

483.43  
5

A

# DISCOURSE

Concerning the

*Circulation of the Blood:*

BEING AN

ANSWER to the OBJECTIONS  
lately alledg'd against it;  
especially by Dr. BROWN,  
in his *Anatomical Lecture* upon  
that Subject.

BY

JOHN GARDINER, M. B.

L O N D O N :

Printed for Tho. Parkhurst, at the Bible and  
Three Crowns in Cheapside, near Mercers-  
Chapel. 1702.



Collected by

James W. Smith

1846

From the collection of

the Smithsonian Institution

Washington, D.C.

1846

1846

From the collection of  
the Smithsonian Institution

Washington, D.C.

1846

From the collection of  
the Smithsonian Institution

Washington, D.C.

---

TO THE  
RIGHT HONOURABLE  
THE  
**Earl of Romney,**

*Master-General of Her Majesties  
Ordnance, &c.*

*My LORD,*

**I** Beg leave to Offer to your  
Lordship the First Fruits of  
my Profession, and to Present  
your Lordship some Account  
of those Studies which are ne-  
cessary for the Just Discharge  
of an Employment which I owe  
entirely



*Epistle Dedicatory.*

entirely to your Lordship's Favour and Generosity, for which I am not only on all Occasions in Duty bound to express my Gratitude, but to give your Lordship as frequent Assurances as may be, that I shall endeavour to be Serviceable in the Station wherein your Lordship has been pleas'd to place me.

I am extremely sensible of the Honour and Advantage of so great a Patronage, and from henceforth shall Consecrate the Labours and Studies of my Life, to the rendering my self in some measure worthy of the continuance thereof.

of an employment which I owe  
A 2 I

*Epistle Dedicatory.*

I leave it to Men of another Profession, the Historians of the next Age, to attempt your Lordship's Character, and set forth the eminent Services which your Lordship, in several great Posts, has done to this Nation. The great share your Lordship had in the late Glorious Revolution, gave your Lordship the justest Title to the highest Employments the greatest of Princes could bestow; and the constant and uninterrupted Favour of a Monarch, who was as famous for his Judgment in the Choice of his Ministers, as for his Conduct in the Field, will be the noblest Testimony to  
Posterity



*Epistle Dedicatory.*

Posterity of your Lordship's  
Integrity and Abilities.

It is with the greatest Satisfaction in the World, that the People of this Nation do, at this time, behold a Person of your Lordship's truly Generous and Heroick Spirit, so near Her Majesties Person, being sensible that the chiefest Use and Advantage your Lordship makes of your high Station, is to communicate the greater good to such as either want or deserve your Lordship's Protection and Encouragement; the truth of which appears beyond contradiction, in the great numbers of such as owe their Fortunes and Preferments

*Epistle Dedicatory.*

ments to your Lordship's Generosity.

In the following Sheets, I have attempted the Defence of a Truth, which, from its first Discovery to the World, has met with very little Opposition. Whatever may be the Success of my Undertaking, my Ambition, I am sure, is gratify'd to the highest degree, if I can meet with a Pardon for the liberty I have taken, to assure your Lordship, and the World, that I am, with the utmost Respects and Duty,

My L O R D,

*Your Lordship's most Obedient, and  
most Devoted Humble Servant,*

JOHN GARDINER.



means to your Lordship's service

and the following facts

have encountered the pleasure

a time which from its full

Discovery to the world has

not with very little delay

tion. Whatever may be the

Success of my Undertaking

my Anticipation I am sure

gratified to the highest de-

gree if I can meet with a Li-

don for the liberty I have ta-

ken to assure your Lordship

and the World that I am with

the utmost respects and

My Lord

Your Lordship's most Obedient and

most Devoted humble Servant

JOHN GARDINER

Dr. BROWN,

**W**HEN first I heard you run Counter to the Orthodox Opinion of the Blood's True Circulation, and declaim against it in a Publick Lecture, I scarce question'd but I should quickly see some one take up the Cudgels in Vindication of Harvey's Hypothesis, that it might still confer the same Honour and Reputation on its First Founder, as it has done since its Birth. I don't doubt but 'twas love of Truth that first set you to work to untwine so fair a Thread, and pull down to the ground an Hypothesis which the generality of the World has plac'd the highest of any, and seems to prize the most; it was the same Reason induc'd me to maintain and defend it. Another Strong Motive which prevail'd upon me was, to bear that Opinion contradicted which was the first Principle and Groundwork of the Modern Physick, and upon the discarding of which, a Thousand other Hypotheses must stand very tottering, and at last share in the same Fate.

If you once convince me of the Absurdity of it, (as you promise, You'll not leave the prosecution of this Subject till you have given some Satisfaction to the

B

World,



World, That if a Circulation be maintain'd, it must be upon a new and better Basis than that on which it is at present rais'd;) I shall be ne'er the nearer embracing or approving yours, or any other Doctrine, till such time as he that delivers it shall likewise give some Satisfaction to the World, that according to his new Standard he has a better Intelligence of the Nature of Diseases, and can suggest better Remedies for their Cure, than what has been done by those who have trod in Harvey's Steps. To prove the Circulation false, is a bold and an hard Task; but still it is far more difficult to make Physicians consent to that which would necessarily infer they have committed many and great Errors in their practise: For, what is it to condemn so generally receiv'd an Opinion, but in plain terms to declare, That all those who have built upon it as the most solid Foundation, and have guided their Steps according to it, have been all this while grossly mistaken, and, like Mariners without a Rudder, sail'd in the dark, without hopes, or at least with a very blind prospect of Success in their Undertakings? So that should you gain your Ends, and bring many over to your Opinion, to form a Party in opposition to the Circulation, you would still be a Loser by the Victory; the Event of this Unsettledness of Opinions would bring along with it no great Advantage to the Faculty of Physick, but would rather confirm the Thoughts already conceiv'd of it by some, That the Art is wholly Conjectural, and Guess-work at best; the Empirick and Rational Physician will be equally esteem'd, and the World will conclude, to the detriment of the Profession, that there's a Cheat in our Trade, as well as in all others. I hope then, Doctor, the Liberty I take,

take, since 'tis back'd with so good Reasons, and Self-preservation is in the case, will not at all diminish the Friendship and Acquaintance we have contracted, and I shall endeavour to cultivate; for, as Men naturally love their Freedom in every thing, so they shew their chiefest Inclination to it, in speaking their Minds in matters of this nature; as appears from the various Disputes and Dissentions among Physicians about the Theory of Physick; but what is worst of all, there is always least Safety to be expected from a multitude of such Counsellours, so different are their Sentiments, and their Judgment about the Causes of Distempers as uncertain, and very often contradictory. I grant this is a great Argument, that most Hypotheses are nothing real in Nature, but have their Existence only in Imagination; but, Why should I suspend my Belief? or, What need any Dispute about a thing we know to be infallible by the undoubted Testimony of our Senses? The Circulation, according as it is establish'd, is so plain in it self, that it stands in need of no other Art to support it, but we may from Inspection have a nearer and shorter assurance of its Reality: 'Tis an easie matter to lay bare the Crural Artery and Vein, and by that means the Circulation of the Blood may be plainly discern'd by the naked Eye, Exemplo monstrante viam.

Had the Circulation been ground'd upon Philosophy, there had been reason to suspect the Arguments brought to defend it, and suppose the shallowness of Man's Reason might make 'em slippery and uncertain; but, Is there the least reason to render the Circulation suspicious, when 'tis laid down and prov'd, not from any other Books than those of Nature and live Dissections,



ons, not a Philosophical Figment, but what every days Experience teaches, and is still more and more confirm'd by Reasoning? 'Tis true, an ingenious man may start Objections against the most plausible Opinion in the World, and again, by a witty Argument, can maintain an absurd one, tho' quite thrown out o'th'-doors. Scarce any thing has been affirm'd or denied in Physick, but that the one has been contradicted whilst the other has gain'd Profelites. It is a wonder to me, that notwithstanding what has been said in defence of the Aphorisms of Hypocrates, and many eminent Physicians have set their Hands, to certifie the Verity of 'em, especially Galen that esteem'd Interpreter of his Works, yet that nevertheless any one should be found to detract from their Credit and Reputation, as Sinapius has done, in his Treatise de vanitate & falsitate Aphorismorum Hypocratis, wherein he endeavours to prove their Uncertainty and Deceitfulness, and plainly professes, whoever relays upon 'em will be forc'd to take other measures, and make his Observations quite contrary. I do in no wise mention this to put a Contempt upon, or to slight, those celebrated Aphorisms; but what I would infer from thence is, that if an Author whom the honour of having brought many ingenious Hypotheses into the World, has plac'd in the highest Rank and Order of Physicians, should still meet with Enemies opposing a Work of that importance and use, that then it will not be so strange to find Harvey's Hypothesis liable to meet with some rubs, and have Adversaries who are willing, but can never be able, to bring it into any disrepute, or cast any slurs upon it which cannot easily be wip'd away. I am resolv'd to examine, whether or no the Accusations you alledge against the Circulation are undeviable; but,

in order to the just trying of the Cause in hand, I shall not at the first Onset deal with it as you have done by the Circulation, condemn it first, and try it afterwards; 'tis far from Equity to abuse an Hypothesis, and afterwards to enquire whether or no it has deserv'd such usage from your hands. This I may with Modesty affirm, That your Hypothesis, and that of Dr. Harvey, are in every respect opposite to one another, and contradictory in every point and particular, so both cannot be on the right side o'th' Hedge: 'Tis no Argument of the Truth of your Hypothesis, tho' by it you make your Promise good, and account for the Diastole and Systole of the Heart and Arteries; for if it fail in one Phenomenon, it is sufficient to argue from thence, that it is erected upon an infirm and rotten Foundation; nay, tho' you might solve all the Difficulties of the Blood's motion, it would not be a certain mark of the reality of what you propose. There are particularly in Astronomy two Systems repugnant one to another, one affirming the Earth to be the Centre, and to stand immovable in the middle of the World, while the other asserts it to be a Planet, and takes its diurnal progress about the Sun; yet by both these contrary Systems 'tis an easie matter to account for the Eclipses, the rising and setting of the Sun and Moon, and the revolution of Years and Days, with the other Phenomena of the Heavens. Since then we are in such a Streight, the most convincing Argument of the Truth of an Hypothesis is, its having the fewest Objections of any, and the greatest Arguments in its defence; Why then should not that of Harvey stand firm and unalter'd? If your Objections be answer'd, and it be made appear, that they are so far from pulling it down to the ground, that they do not so much as shake



it, but that they rather serve to illustrate and confirm it; and when at the same time you are made sensible how many and great Inconveniencies the Body must be subject to from your Doctrine of the Blood's Stagnation, and what Objections are levied against it, beyond what Harvey's Hypothesis has ever been expos'd to. I shall go no other way to prove the Circulation so well receiv'd, and so plainly demonstrated from the disposition and structure of the Blood-vessels themselves, and the Valves, and their Order in the Veins, from the admirable Dexterity and Mechanism of Nature, and the manner whereby Nature prepares the Chyle for the nourishment of the Body, and preserves a Circular Motion in all the Fluids; for, What Defence will it be to Harvey's Hypothesis to say any thing in its behalf which hath been said already: and since there requires very little pains to prove a Notion so clearly establish'd, and which you call The Darling Opinion of the Age? So that should I take any other method to praise the Circulation, might I not reasonably expect the same Repartee as was given to a Philosopher, who when he was going to make a Panegyrick upon and extol the Fame of Hercules, had the Question put to him, Who did he think could blame him? or, Was any body there present going to lessen his Reputation? Only give me leave to say, That as we draw a Conclusion from several Circumstances, which amount to a demonstration that several Juices in the Body, besides the Blood, preserve a Circular Motion, particularly the Animal Spirits, because they are continually sent to the Parts, and in too great a quantity to be so suddenly regenerated; and because 'tis necessary there should be two sorts of Tubes, one for the Spirits to descend in from the Brain, and which serve for the motion of the

Parts,

Parts, and others for the conveyance of those Spirits back again, to represent the Sense of the Object to the Brain. So likewise we draw the same certain Conclusion, That since the Blood runs from the Heart in four minutes time, and its richest parts are consum'd upon the Nourishment of the Body, and in the performance of several Secretions, and so a great waste cannot be so soon recruited; that then the Blood must return to the Heart, to be made partaker of its Vital Spirits, & ut ibi requatur.

Sir, I don't intend to forestall the Subject of the following Sheets; but to give you a short Tast of what you are to expect while you continue in your Infidelity, and bid defiance to so plain a Demonstration; but give me leave to tell you, that before you had resolv'd to refute the Circulation, it had been requisite to have been very well acquainted with it in all its points and circumstances, arm'd against it not with the multiplicity, but with the force and weight of Arguments, being sure that the Circulation had been too weak and insufficient to withstand or make any resistance, Nullos habitura triumphos, lest after you have express'd your Joy for the Victory you have obtain'd over it, you may still find it alive, to revenge your hasty Triumph. I confess, Doctor, your Complaint is justly ground'd, That some of your Audience were a little too hot-headed, and ran too fast for the Circulation, that they took their Revenge too hastily; and you have reason to blame 'em for the Interruption they gave you; but yet I cannot be perswaded that any there, thro' Heat or Ignorance, unjustly denied your Quotations; for I observe, up and down your Lecture you have often misconstrued Harvey's Words, and put a different Sence to 'em.



'em, as it serves for your purpose, at other times making Harvey teach what would utterly destroy his Circulation; and therefore must suppose it a Mistake, till you referr me to the Page, and give his own Words, which would have been the easiest and most natural method for every Man's Satisfaction.

Now, that I may no longer detain you from seeing what Execution your own Objections are likely to do, give me leave to add but one thing more, not by way of Advice, but as my own private Thoughts, That when Men are possess'd with Notions contrary to the Sentiments and Opinions of the rest of Mankind, 'tis fair and reasonable they should let their Minds be known to the best advantage, since otherwise the greatest Truths, and the Benefits arising from 'em, had lain conceal'd to no use and purpose; but then, Doctor, they ought to carry along with them this Precaution, That what they propose should not come by way of Opposition, and to humour their own Imaginations, but to convince Men of the Truth and Reality of their Hypothesis, which appears when they shew a Desire not so much to undervalue and destroy what other Authors have built, but to leave their own and other mens Performances to be judg'd by the Impartial Reader.

Yours,

JOHN GARDINER.

---



---

THE  
CIRCULATION  
VINDICATED.

**A**FTER that the Hypothesis of Doctor *Harvey* has for near an Hundred Years enjoy'd a state of perfect Rest, without any manner of Interruption in its course, but continually new Experiments and Observations serve to settle it more in the good Opinion of the World; What Hypothesis hereafter will stand firm and unalter'd, when at last we see an old antiquated Notion reviv'd and brought upon the Stage to contradict the *Circulation*, and propos'd not only as more reasonable, but also less difficult to solve the several *Phænomena* of the Blood? But since the Question is, which has the greatest shew of Probability, and the strongest Arguments on its side, I know no properer method than to examine the difference between them, and by setting them face to face, we shall quickly discern the Marks of Truth in the *Circulation*, whilst the inconsistency between one part and another of the Anticirculator's Doctrine shall prove a means to render the *Circulation* still more



conspicuous and intelligible; and what will prove its chiefest defence, is, that what they alledge against it, is rais'd from Principles altogether as precarious as the Objections are weak, and insufficient to do any execution.

To avoid Repetitions, I shall forbear laying down at the beginning an exact Scheme of either one or the other Hypothesis, since the nature of the Dispute is such, that in defending one, both must of necessity be display'd: I shall only remark, that the Doctrine of *Hippocrates* touching the Bloods motion, and that of the Anticirculator's, are built upon the same Foundation, and the Principles they both go upon are of the same nature; yet the Superstructure the Anticirculators have establish'd upon those Principles are very different, and accompanied with greater Difficulties; as will appear, if we consider what their Judgment and Opinion is touching the bare Motion of the Blood. In the first place they utterly disown a Possibility of the Bloods moving in *Circulum*, or that when it is sent from the Heart by the Arteries over the Body, it should ever return by the Veins: but think it necessary to allow but two sorts of Motion to the Blood, one whereby its Particles move in their own Place and Vortex, and which Mr. *Boyle* has sufficiently prov'd to be in all Liquids, so long as they retain their fluidity; that this intestine motion, together with the influx of the Spirits, is sufficient to preserve the *Blood* in a due mixture and Crasis; and that all the Advantages which *Harvey* imagin'd did proceed from a swift *Circulation of the Blood*, might easier be accounted for by a slow progressive motion of it, whereby it is convey'd to the Extremities

ties in no greater quantity than what will suffice for the last expence the *Blood* has made upon the Parts, and to fill up the vacancies; which sort of motion is so far from affording any advantages to the *Body*, that we might reasonably expect all the Inconveniences that attend a downright stagnation of the *Blood*. What is thought a great Argument to confirm this progressive motion, is the manner whereby the Juice rises in Plants to their Extremities; but yet if we consider the late Discoveries made upon the nature of Plants, we shall find a great Analogy between the circulatory motion of the *Blood* in Animals, and of the nutritious Juice in those; as *Malpighius* and *Dr. Grew* have plainly prov'd, they bear a great resemblance both as to the efficient Cause and Manner of their Circulation, since by the Anatomy of Plants there is observ'd to be in them what may answer to the Heart and Arteries, Veins and their Valves, to all the Vessels and Vesicles which are requisite for the Circulation of the *Blood*. Tho' the Anticirculators are averse to the *Bloods* motion according to the Systems of *Harvey*, *Lower*, *Walleus*, and those who have wrote on their Notions, yet they seem to be willing to conform, if they might frame one according to their own Humors; and therefore not denying but that some portion of the *Blood* distributed over the *Body* might in tract of time return to the Heart, yet they can't be perswaded that the Veins are design'd to carry the *Blood* back, but that this Revolution must be perform'd by the Arteries; and the reason they give for it is, because they find *Anastomoses* between one Artery and another, when there is found no such thing between a Vein and an Artery



all over the *Body*, except the *Liver*: but to answer this Objection, as there have not been observ'd any *Anastomoses*, except between one Artery and another, so neither does the Circulation require any other.

Nor was there any reason to have excepted the *Liver*, since the *Veins* and *Arteries* are as far from intercommunicating together there, as in any other place whatever: but the *Antic.* are not aware of the many Contradictions from this one part only of their new Circulation, to mention but one at present, whilst they suppose the *Blood* to be convey'd by the *Arteries* to the *Extremities*, and in process of time return'd by the same *Arteries*; it implies two contrary Motions in the same Pipe and Canal: According to them, the *Veins* and *Arteries* convey *Blood* the same way, tho' by examining their formation and structure they might easily conclude they were design'd for different ends and purposes. So notwithstanding the Make and Constitution are the same of both the *Ventricles* of the *Heart*, the same disposition of *Fibres*, the same *Valves*, *Vessels*, and *Auricles*, and both are found full of *Blood* in Dissections, yet the *Antic.* allow *Blood* to be in the right *Ventricle*, and suppose the left to be only as a Storehouse for the *Spirits*, where they are kindled into a *Flash*, or *flamma vitalis*, serving for the pulsation of the *Heart* and *Arteries*, and producing several great effects in the *Blood*: but as to the generation of these *Spirits*, they assert that so cold and unactive a body as the *Blood* is, cannot be able either to make or bring them to perfection, and therefore must come from the *Air* into us by *Respiration*, and from the spirituous part of the *Chyle*, passing thro' imperceivable holes in the *Septum* into the left

*Venæ*

*Ventricle.* I shall take another occasion to enquire whether the *Lungs* and the *Septum* are capable to transmit these airy Spirits into the left *Ventricle*; and supposing they should be there, whether or no the Effects ascrib'd to 'em might not be explain'd more to our satisfaction from the *Circulation of the Blood* and the *Spirits* incorporated with it, than from the *Spirits* alone, without any dependance on the *Blood*. These are some of those Paradoxes which I heard a Physician of one of our own Universities defend, tho' the method the Doctor took to cry up the merit and raise the reputation of his own Hypothesis, was by declaiming against *Harvey's*, and endeavouring to convince us of the unreasonableness of the *Circulation*, before he had prov'd his own to be more plausible. Since therefore my Intent was to enquire, Whether the *Circulation* was intelligible after that the Doctor assur'd us that none present could tell what to make of it, and see whether I had any reason to forsake or disbelieve it; that I may be more fully satisfied in it, I shall not confine my self to a strict prosecution of his Lecture; but seeing he pretends to do Justice to the Author of the two Essays against the *Circulation*, and espouse his Cause, I shall take the freedom to select the chiefest Objections from both, which seem to strike more evidently at the Root of the *Circulation*, not regarding those little snarling ones, which can shew their Teeth, but would sooner tire the Reader's Patience than deserve an Answer. I shall just give a short view of one or two, with which they make their first Onset, that from a taste of them it may be imagin'd why I think more of the same nature would not be acceptable.

First,



*First*, They pronounce it absurd, and contradictory to common Sense and Reason, and altogether unintelligible as it is set down by the *Circulators*; and, as *Harvey* confesses himself, the knowledge of it is abstruse, and difficult to be attain'd to: besides, there can be no final Cause assign'd for the Blood's galloping so swift and in such great haste through the body. These are some of their fine strokes, and of a piece with the rest; but if the *Circulation* is so absurd as they would have us believe, and the belief of it has spread it self so universally, how universal too must that Ignorance be that has escap'd none beside themselves? There had been some colour for their Complaint, had they only shewn a *Distrust* that the *Circulation* was not clearly made out to their satisfaction, that something more might still be added to bring it to its ultimate term of perfection and improvement: but to think so hard of the *Circulation*, after so many convincing Proofs of its reality, is an argument they would not be convinc'd, though they could enter with a Candle and Lantern into live bodies, and discern it with their own Eyes.

I grant *Harvey* confesses it to be an hard and laborious task to explain the several *Phænomena* of the *Blood* by his new *System*, as he says himself, *Nec enim quomodo Systole aut Diastole fieret nec quando aut ubi dilatatio aut constricção existeret recte potui cognoscere*: Nor could he exactly compute what quantity of *Blood* was expel'd at every contraction of the Heart; besides, to find a passage for the *Blood* out of the *Arteries* into the *Veins*, was, without doubt, what very much puzzled him. All that can be gather'd from this Objection is, that *Harvey* did not, as it was impossible

possible any one man should, on a sudden settle all the points of the *Circulation* beyond dispute; that as this new Hypothesis has cost great Pains, and has met with Difficulties, it argues only that greater Honour is due to the Author and Inventer; the greater the Trouble he has met with in rearing an Hypothesis, our Acknowledgments ought to be proportion'd: But because the *Circulation* is not superficial, but lies deep, and to be discern'd by the Eye of Reason, is that an Argument against it? or, Should it be thrown by, because presently some one Propriety of it cannot be made out to every man's satisfaction? It is one thing to know for certain that an Hypothesis is false, and a quite different thing not to understand how to reconcile it to our Reason. Here are an hundred good Arguments to support the *Circulation*, but is one or two Objections sufficient to sway against 'em all? We cannot dive to the bottom of Nature in any one thing, so as to know her perfectly well; the generation of Animals can never be fully explain'd by bare Matter and Motion; or, Can we understand by what Hooks the Parts of Matter become so united and link'd together, as to form the Body of Animals? but from a difficulty in perceiving which way 'tis done, shall we conclude that there is no union of, or adherence between, the Parts of Matter? Mr. Ray speaking of the method of the generation of Animals from Eggs, says, *He can't imagine how there should be any such things as monstrous Births with two Heads, or supernumerary Arms and Legs, since it must be suppos'd these Eggs came perfect out of the Creator's Hands*: Yet he is so far from being discourag'd from embracing that Hypothesis, that he modestly confesses,



fesses, tho' he could give no reason for such an Effect  
 yet perhaps some one after him might hit upon the  
 Cause. 'Tis certainly a Glory to an Hypothesis to  
 have such unreasonable men for its Enemies, as from  
 its being difficult would conclude it absurd. Besides,  
 should it be true what the *Anticirc.* object, That there  
 can be assign'd no final Cause or Intention of Nature  
 for the *Circulation*, it would not be a convincing Ar-  
 gument to prove it false: For tho' I acknowledge  
 that famous Axiom of *Aristotle*, *Quod Deus & Natura*  
*nihil faciunt frustra*, yet the Opinion of *Cartes* about  
 the judging of Final Causes, is as reasonable, viz. that  
 it is in vain to be inquisitive about 'em, and presum-  
 ptuous to think to discover the Purpose and Design of  
 GOD in his acting about his Creatures; for there are  
 several *Phænomena* in Nature which we can give no  
 reason for their existing: but, may we from thence  
 conclude they are wholly useless and insignificant? Is  
 the Consequence good, that because some persons may  
 imagine the *Circulation* might have been let alone,  
 without any detriment to the Body, that therefore  
 there is no such thing?

He was a bold man who said, *If he had the making*  
*of the Eye, he would contrive it more advantageously for*  
*the benefit of the Sense of Seeing*; for should he frame  
 that Organ with the greatest dexterity and artifice  
 imaginable, yet considering the Consent and mutual  
 Dependence between all the parts of the body, he  
 had reason to fear (unless he understood the whole  
 Composition and Frame of an Animal) that by ad-  
 ding or diminishing, the other parts might suffer a  
 Disadvantage, as the least alteration imaginable, tho'  
 in a place remote from the Eye, as a Thorn in our  
 Finger

Finger brings Disorders not only to that part, but to the whole Body. But what I would infer from thence in relation to our present Case is, That altho' the *Antic.* imagin that their Progressive Motion is not attended with a quarter-part of those great Difficulties the *Circulation* brings along with it, yet let 'em take care to answer for all those Damages the Body might sustain from their Hypothesis. Because Nature is said to *do nothing in vain*, must we therefore conclude she always acts in a plain and easie method, and takes the most compendious way to work in? *Ludit in humanis divina potentia rebus*; and Nature may very well be compar'd to a Mathematician, who when he can with one stroke of his Compass divide a right Line into two equal parts, chuses to go the furthest way about, as the most secure, and do it by a Circle; so we observe Nature follows this Rule in the distribution of the Chyle, and the manner of its mixing with the Blood; for since the common Receptacle is plac'd in the middle of the Loins, very near the *Vena Cava*, we might imagine that a communication from the Receptacle to the Vein would have been the most natural as well as the quickest passage for the Chyle into the Blood, without a long tedious compass from the Receptacle into the *Ductus Pectoralis*, and so forwards into the Subclaveal Vein, from whence it passes into the descending Branch of the *Vena Cava*, and with the Blood falls into the Heart; but 'tis for this reason Nature has so order'd it, lest the Chyle mixing with the Blood as it rises to the Heart, should retard its motion, and hinder its ascent, by its chilness allay the heat of the Blood; and partly, that it should attain to a greater degree of Purity from a kind of *Circulation*.

D. So



So the Heart is depriv'd of the Privilege formerly ascrib'd to it, as being the chief Bowel, and Place for Sanguification, since 'tis known that the Chyle remains crude in the Heart, and puts not on its Flood-colour while it remains there, but by often circulating with the Blood, and undergoing several modifications in its passage, becomes at last spirituous, and of the same nature with the Blood: For if the Chyle arriv'd to that degree of perfection, and was so much chang'd in the Heart, as the *Antic.* suppose, how can we account why Chyle in its crude form should, upon opening a Vein, be discharg'd together with the Blood, unless by saying that it has not been strein'd often enough thro' the Body, nor has the *Circulation* been perform'd so frequent as is requisite for the converting of the Chyle into Blood? The reasons for so swift a *Circulation* cannot be better explain'd than by considering the benefits arising from it; and these will appear, if I proceed to answer their next Objection in course, and that is, If the knowledge of the *Circulation* was so necessary to the Practise of Physick; the Consequence would be, that the Modern Physicians would cure more than the Ancients; but we find the contrary. This Question, as we find in the Dialogues of the Dead, was put to *Harvey*. when *Erasistratus* met him in the *Elysian* Fields, How comes it to pass that if the Moderns know more of Nature, and of the Blood's true motion, by those Discoveries lately made by your self, that as many resort to this place now as formerly, without any difference? *Harvey*, to take off the disparagement this Question might bring upon his new Hypothesis, and  
upon

upon those who walk'd in his Steps, is feign'd in a jocose manner to make this short Reply,

*Oh ! s'ils meurent, c'est leur faute  
Ce n'est plus celle des Médecins.*

Thus much may serve for our present purpose, and to answer their Objection, That Diseases are very much alter'd from what they were in the days of *Hippocrates*, and therefore require new methods for their cure ; new Distempers are crept in among us, and more and more complicated with the old ones, and therefore are much more difficult to cure.

The reasons for this Change in Diseases, is the alteration of their Causes from different defects in our Conformation, different weaknesses in our Constitutions, and, what is the principal occasion of all this, from the Intemperance the generality of People now live under, altogether different from the regularity observ'd in former times, and therefore the Moderns may very well be reputed the best Physicians, if they cure but as many as the Ancients ; if they do not, the fault ought not to be laid upon the *Circulation* : For tho' it may be prov'd that it contributes very much towards the curing Diseases, yet it is not the only thing requisite to the right understanding their Nature ; 'tis certain that by the knowledge of it Physicians can better discern the *Diagnosticks* and *Prognosticks* of a Distemper, but yet a Cure for it must be sought from other Principles than what *Anatomy* teaches. Besides the being acquainted with the true motion of the Blood, if Physicians would be infallible, they must rightly understand the Composition



of it, and the nature of its Principles; nor do I believe any help can be had from the Chymical Analysis of it, for the Principles, which by the help of the Fire are drawn from *Blood*, as *Phlegm*, *Salt*, and *Oyl*, the same may be had from any other part of an Animal with any distinction. Yet supposing them to be actually in the *Blood*, the method Nature takes in mixing and uniting those Principles is in such a peculiar manner, as from thence to result a Compound of another nature, and Proprieties quite different from the Principles which make up its Composition. All we can discern by the help of a Microscope are round Globules swimming in the *Latex* or *Serum*. But still that there has been little discover'd as to the Nature of the constituent parts of the Blood, is evident that Physicians have not as yet agreed, whether in curing a Disease they ought to have a chief regard either to the four first Qualities, or the four Humors and the Temperaments depending on 'em; or are satisfied, whether to ascribe the Cause of a Disease to a sweet, a bitter, or a sowre in the Blood, till they can be sure to a predominancy of which Diseases owe their Origin, they are like to seek for a Remedy to effect a Cure. But to keep closer to their Objection, That no one has proved what Advantage the Practise of Physick has had from the Knowledge of the *Circulation*, it will not be amiss to give them *Harvey's* own words, whose Judgment in this case may best be taken, since 'tis suppos'd that he, who was the Author of this celebrated Hypothesis, is most likely to be sensible how much it has conduc'd to the Improvement of Physick; *In omni parte medicinae Physiologica, Pathologica, Semiotica, Therapeutica, cum quanta dubia solvi quot obscura*

*obscura dilucidari animo mecum reputo mihi forsan vita ad finem faciendum defueret.* If the Deposition of *Harvey* will not suffice, I shan't pretend to set off the *Circulation* any further than what will serve to invalidate their *Objection*.

Which way could the *Antic.* account by their slow progressive motion for the many Pulsations, as in *Fevers* to amount to above Eight thousand in the space of an hour? What reason can they give for the variety of Pulses, according to the different Ages and Sexes, different Constitutions and Distempers of Persons is the rarefaction and condensation of the Air in the Heart and Arteries, sufficient to satisfy any reasonable man without going farther to seek for a Cause? or, Can we with the *Antic.* ascribe it to the Spirits in the Left Ventricle passing into the *Blood-vessels* by jerks and puffs, rather than to the rushing in of the *Blood* into the *Arteries* by the constriction of the *Heart*, and their subsiding or falling again to their natural state, when the cause of their dilatation is remov'd in the time of the Hearts Diastole: How should these Spirits be so regular in their motions? How could the Beatings be so even, and with distinct Intervals without any intermission, since the Spirits being of an expansive nature, would rather keep the Heart in a state of dilatation, and being susceptible of disorderly and tumultuous motions, would rather make me believe they would force the *Blood* out of their proper Vessels, than so calmly and quietly pervade it, without causing any manner of disturbance to the *Blood*? 'Tis hard to conceive how these Spirits, which can't be divested of their materiality, should be self moving, not depending from the

mo-



motion of the Heart, or receiving any force or Spring from any part, yet notwithstanding should so determine their Course in such constant order, as to be distinctly felt keeping of time in the Extremities of the Body, especially considering the opposition and resistance the Blood makes, the natural tendency of the Arteries to keep always in a state of Contraction, and to remain flat, requires a considerable force to open and dilate 'em? But the Dr. seems to wipe away all cause of Suspicion, that the *Spirits* might create in its passage any disorder, and drive the *Blood* before 'em; but he should have been sure that the *left Ventricle* does contain nothing but these *Spirits*, before he had endeavour'd to explain their Functions, and the manner of their Operations. But I shall stay no longer at present upon this head, since my design is only to shew, that the knowledge of the *Circulation* does contribute much towards the right comprehending the Nature of Diseases, by the light it gives to discover the Reasons for the variety of Pulses; and I shall take another opportunity to shew that the *Antic.* have no ground to suppose that the *left Ventricle* is a Storehouse for the *Spirits*, any more than they have to find a short cut for the Urine, to the Kidneys by the *North Pole*, as they call it; since a passage any other way than by the *Circulation* has been confess'd by all hands to be uncertain and hitherto undiscover'd. But what need they seek for a new way, since its sudden and quick motion is easily accounted for mixing and circulating with the *Blood*, insomuch that we may easily judge of the celerity of the Bloods motion, from the quick Secretion of Urine; for suppose the *Serum* to be one half of the *Blood*,

*Blood*, and that this *Serum* is not all discharg'd from the *Blood* in its being strein'd through the *Kidneys*, and that three Pints of *Urine* is separated in an hours time; we compute that above twice that quantity of *Blood* has pass'd thro' the *Emulgent Artery* in that time. But the chiefest Benefit that we receive from the knowledge of the *Circulation* is, that we have from thence an Insight into the Mechanical Operations of Medicines upon Human Bodies, from Reasons and Experiments agreeing with the *Circulation*, when the Ancients, who knew nothing of the *Blood's true motion*, imagin'd they acted by a Charm, or some occult Quality. But Dr. *Willis*, in his incomparable Treatise of his *Pharmacentice Rationalis*, grounding his *Discourse* upon the *Circulation*, explains the manner of the Operation of Medicines both by irritation upon the coats of the Guts and Stomach, and admission into the Blood, as the proper'st and most expeditious way to dislodge the morbidick Particles, and dispose the Blood to throw 'em off by Sweat, or by the Glands of the Guts and Stomach.

It may easily be prov'd, that not only *Physick*, but *Chirurgery* too, has been advanc'd by the knowledge of the *Circulation*: I shall only add, That the Ancients puzzled their Brains about selecting a *Vein* to bleed in, according to the Seat and Nature of a *Distemper*, from a wrong Notion they had that one *Vein* discharg'd the Blood from the Head, another from the middle parts, and the third from the inferior. Now, since 'tis fully prov'd by Ocular demonstration, that the *Veins* are destin'd to convey the *Blood* back to the *Heart*, after it has been carried



ried to all the parts by the *Arteries*, and that none can come by the *Veins* to the *Extremities*, it is reasonable to conclude that one *Vein* in the Body may be open'd indifferently, and with equal Success, unless the case is alter'd. As for example; When any part in particular requires an Evacuation or Revulsion. But since the *Circulation* stands not in need of any defence which I can make, my design was no otherwise to set off the *Circulation*, than by accident in answering their Objections; I shall pass to the next as they lie in their Discourse, and in examining of them, as being something more material, we may observe how the *Antic.* are putt up, *Nescio quo spiritu flatulento*, and with the hopes of succeeding in this dangerous Enterprize, where, to use their own words, *they are like to be ran down by the Torrent of the Circulation*: But since they seem unanimous in their Resolutions to destroy the *Circulation*, it had been requisite to have been so in the measures they took to effect it: Theirs is a politick Case, where 'tis requisite all of a Party should be all of one mind, that they may be the better able to combat with and fight against their Adversaries. 'Tis not without reason that I put 'em in mind of this Union, since instead of that, one maintains what the other disproves; and what is worst of all, they can say one thing when it serves for their turn, and as soon unsay it again, when in doing so it makes for their purpose: For else how comes it to pass that Mr. Hill allows but one *Coronal Artery*, and that distributed over the Walls of the *left Ventricle*, for their nourishment, without dispersing any Branches to the *right*? But the Doctor, as he has great reason, confesses

fesses that there are two, why does Mr. *H.* suppose, and take for granted, that the Blood in the right *Ventricle* is sufficient for its nourishment, when the Dr. seems to be asham'd of so palpable an Error, and acknowledges that the Blood, while in the Heart, is as unfit for that end, as while contain'd in the *Arteries* it is incapable to nourish the other Parts of the Body? This is a wilful mistake of that Gentleman, since 'tis beyond dispute, and may be plainly perceiv'd, that there are two *Coronal Arteries* which encompass the Heart, and extend many little branches from the *Basis* to the *Cone*, of which the major part and largest are sent to the left *Ventricle*, according to the degree in which it exceeds the right in bigness. But if Mr. *H.* could make others shut their Eyes, as he seems to do in this case, then he might reasonably have expected from that ground to form an objection against the Bloods being in both *Ventricles*; which, indeed, if the *Antic.* could any ways make out, there would be an end of the *Circulation*, without going any farther, according to the Rules of all the *Circulators* in general; and therefore 'twill be necessary to consider, how cogent the Reasons are which induc'd 'em to believe that in a Natural State no Blood is contain'd in the *Left Ventricle*. The first is, Because no Man has ever prov'd, that whilst Life remains, there is Blood in both *Ventricles*; and that *Harvey* himself affirms, That in Dissections, as soon as possibly he could open the *Left Ventricle*, he has always observ'd little Blood to be in it, but very often none at all. But notwithstanding, supposing it to be so far a true Objection, that no one has prov'd it, and that *Harvey* has made those Ob-

E

servations,



servations, yet the only proof which the nature of the thing will bear, is drawn from Circumstances; and 'tis certain, that if the Blood runs from the Heart by the *Arteries*, and returns again thither by the *Veins*, as is both seen and felt, that this Blood must of necessity pass through the *Left Ventricle*, since there is no other way to get into the *Arteries*, considering that the *Aorta*, or great *Artery*, which is the root of all the *Arteries* in the Body, except the *Trachea* and *Pulmonary Arteries*, has its origination from the *Left Ventricle*, and has no communication with the *Right*.

This is a greater Argument for the Bloods being in the *Left Ventricle*, than because it has not been prov'd, whilst Life remains, is an objection against it; for it is impossible to come at the Heart, while all things remain in a natural State, and to see its Functions and Working, whilst Life is in its full force, to convince 'em whether Blood is there or no. But yet I don't find where *Harvey* says any thing like the Quotation they have made; but I am sure he says quite contrary, upon the same Ocasion, in his Second Chapter, where he expresses himself thus upon the Matter, *Similiter in dissectionibus arteriam venosam & sinistrum ventriculum videmus tanta copia Sanguinis abundare quo dexter ventriculus & vena arteriosa replentur*. Which of these two contrary Quotations is the proper and genuine sense of *Harvey*, will appear if we take notice, that on the one hand he is made to contradict himself in the most material Point of the *Circulation*, and consequently from his Mouth, to pronounce Sentence against it, when on the other hand, the sense of these last words are

are agreeing with the rest of his Hypothesis, and differently repeated, to assure us that he has found Blood in both *Ventricles*, without any difference: *Sanguine ejusdem Consistentia & Coloris tam sinister, quam dexter ventriculus semper est repletus*; and therefore should the *Antic.* have justly cited *Harvey*. They ought beside to lay down an Account of the Accidents occurring in the Experiment, after what manner the Animal dy'd; and besides the bare words of the Author, give likewise his whole Opinion about the Matter, that from thence we may observe the Reasons why such and such unusual Observations have been made. But if the *Antic.* have endeavour'd, and are fully resolv'd to ruine the *Circulation*, and that the Blood is in both *Ventricles* is a main Branch of it, it ought to be their business to prove the contrary; and this they think they do, by bringing us an Example from dead Bodies, where they find no Blood in the *Left Ventricle*. And by the same way of arguing they may prove, that while Life remains, there is no Blood in the *Arteries*, because after Death they find the *Veins* to be a Receptacle to the whole Blood in the Body: But is not this an excellent comparison, between a Heart in a sound state, and at another time when the Animal is either dead, or at the last gasp, and the Heart is debilitated, and its vital Operations at an end? But yet they may be assur'd, that if they cut a Dog open alive, and tie the great *Artery* near the *Ventricle*, or the ascending and descending Branches of it, they will find Blood equally in both *Ventricles*: Where, by the way, we may observe, That if the Spirits could at any time, by their resistance, hinder the falling of the Blood into



that *Ventricle*, as they say they do in Animals that have been Strangled, but that the reason why we sometimes may find Blood there, is, because by a slow and lingring Death, the Spirits, by consuming, and being spent upon the Parts, have not force to keep the Blood off; Then what should be the reason, that in the Case I instance, since the Spirits, if there are any such as they suppose, must needs be concentr'd, and in a great quantity, we still find they have not force to hinder the reflux of the Blood? It must be confess'd, that in Persons who have been Strangled, the *Left Ventricle* is not only empty of Blood, but Spirits too: But then, that we may avoid mistakes in making our Remarks, we must take care how we draw Conclusions from what we see in dead Bodies, especially those that dy'd by some violent means, for in those Instances, when we observe some Parts full of Blood, others entirely shut up, and have nothing within 'em, we cannot be sure that those Parts were so dispos'd in a Natural State as we then find 'em, whether it is not the Effects of the strugglings of Nature, and the violent Commotions, at the same time, in those Bodies.

There may be given a very good Reason, why at such a time we may find no Blood in the *Left Ventricle*, but the Right only to be full, if we consider that the Respiration and the Motion of the Heart ceases not both at the same time, but the Heart may beat for a considerable time without the help of Respiration, as is observable in Hearts taken out of the Body; and then it will be that the *Left Ventricle*, by the *Systole* of the Heart, may very well discharge the Blood into the *Arteries*, while the *Right Ventricle* has

has no other outlet to send the Blood by, but through the *Pulmonary Artery* into the Lungs, which for want of Respiration, is already choak'd and fill'd to an extremity, with stagnating Blood, and too much loaded to admit any more by the way of the Lungs; and therefore from the same reason, that the *Right Ventricle* is full of Blood, the Left is empty, both occasion'd from the fulness of the Lungs; and as the one remains turgid, for want of some *exit* and return for the Blood, the other is empty for want of supply into it from the Lungs.

That the ceasing of the *Circulation*, and a stagnation of the Blood in the Lungs, is the principal occasion of the Death of those who have been strangled, is plain from an Experiment made upon Malefactors, immediately after they have been Executed; for by blowing hard into the *Trachea*, as near as may be, in imitation of Respiration, the Blood, by the usual pressure of the Air, is drove forwards into the *Left Ventricle*, the motion is return'd, and consequently the *Circulation* and Life depending from it are perfectly recover'd. But because it is agreeable to the Hypothesis of the *Antic.* to account for this Effect, from the admission of the aery Spirits into the Blood, without any necessity of a *Circulation*, to see how groundless their Supposition is, they may observe, that not only blowing into the *Trachea*, but rubbing and heating the Body with warm Cloths, and a draught of Wine, especially Bleeding, which diminishes the Spirits, all tend to the same end, of fanning the Blood, and agitating its Particles, and restoring a motion, heat and fluidity, as it enjoy'd before, and is requisite for its passage through the substance of the Lungs.

The



The next Reason that the *Antic.* have why they can't Consent that *Blood* is in the *Left Ventricle*, is, Because that then neither Heat nor Spirits would be generated, for want of a convenient Place for their Generation, and afterwards to contain 'em. I must readily grant, that in order to the producing of Spirits, there must be allow'd some convenient Space; but since 'tis agreed on by the *Circulators*, that they proceed from the Blood, 'tis sufficient for our purpose only to suppose that tho' the Blood is in both *Ventricles*, yet they are not so full, but they may afford sufficient room for a fermentation, in order to produce this Heat and Spirits. None of the *Circulators* thought the *Ventricles* in the Heart's dilatation to be so full, as not to be possible for 'em to contain any more, for the biggest computation suppos'd to be in each *Ventricle*, does not exceed two Ounces; but we observe upon some Occasions, that they are able to contain much greater quantities, particularly in case of a *Polypus*, when the *Ventricle* is dilated beyond what twice that quantity would fill, besides what *Vesalius* writes that he found in the *Left Ventricle* of the Heart, two Pounds of a blackish sort of flesh, but is look'd upon by *Dremerbroek* to be an Error in the Printer, instead of so many Ounces. But either way 'tis enough, to prove that the Blood, which passes through the Heart, does not so entirely fill the *Ventricles*, but that the Spirits might be generated there, if Nature had design'd the Heart for that end; but for several Reasons, 'tis thought the Heart is unfit for that Office, both because the Blood does not stay long enough in it to undergo a sufficient change, and because in the *Ventricles* nothing is added

added or detracted from it, which could alter its Composition.

What fitter Place can be appointed for the generation of those Spirits than in the Veins, since several Reasons concur to render that Opinion credible; for if we consider, that through the Heart and Arteries the Bloods passage is too quick, and a nimble *Circulation* is in some measure destructive of, or at least abates the intestine motion sufficient for a fermentation, we shall find the Blood in the Veins, having a much slower pace, would give longer time, and more opportunity, for that design. And since 'tis certain, that all fermented Liquors require a larger Space to contain 'em, than when the Parts were more compact, it may be concluded, that since the Veins are two thirds bigger than the Arteries, that they are the most proper place, as being more capacious; but the greatest Reason is, that we see Nature takes care to separate the *Lympha* from the *Arterial Blood*, which because it consists of Parts very tenacious, would, if permitted to pass all of it into the Veins, much restrain the fermentation, and so far bridle the Blood, that its Particles would hardly become minute enough and subtil, for the Spirits to arise from them, and therefore as soon as the Blood is extravasated from the *Arteries* into the substance of the flesh, there are appointed convenient Ducts to receive the *Lympha*, and the Mouths of the Veins carry back the remainder of the Blood. This *Lympha* returns not again into the Blood sooner than the *Chyle*, but mixing with that they pass together, and enter in the hollow Vein near the Heart, and both serve to compose the Blood, and prevent a too long and more than necessary fermentation.



mentation. I may here use the same expression which the *Antic.* have upon another Occasion, and declare my Intention is not to find a place for the generation of Spirits, but only to prove that the Heart is not at all convenient for that purpose, but may be properly call'd the *Exchequer of the Blood*, but not of the *Spirits*.

But then another Stumbling Block to them is, That the Disproportion between one *Ventricle* and another, and between the *Right Auricle* and the *Left*, would certainly interrupt the *Circulation*, and the *Right* would dispense more Blood than could be receiv'd by the *Left*. But then the *Antic.* must prove, that the *Ventricles* are of such an unequal size as they imagine, for tho' it is apparent that is much broader, and has thinner sides than the *Left*, yet the *Left* is considerably longer, and reaches from the *Basís* to the extremity of the *Cone*, and makes up one way what it loses in another. But granting their Supposition to be true, yet the difference in their largeness would not infer an inequality of the *Circulation*, because the Blood coming from the *Vena Cava* into the Heart, is more loose and dissolv'd in its frame than when it has been strain'd through the *vecicles* of the Lungs, and by the pressure of the Air is render'd more compact and united in its Parts, and requires less space to contain it, as a Pound of Musket Balls will take up less compass than the same weight of Small Shot.

That the Blood undergoes a great alteration in the Lungs, will appear the more plausible by comparing the consistence and colour of the Blood in the *Pulmonary Vein* and *Left Ventricle*, with that in the *Right*

*Right Ventricle* and *Pulmonary Artery*, the Blood in these being of a dark and blackish colour, but after it has pass'd through the Lungs becomes red and florid. This difference the first *Circulators* took no notice of, yet those who wrote after them were very sensible that the alteration which they perceiv'd in the Blood, after it has pass'd through the Lungs, must be wholly owing to the new Modifications it has receiv'd in its passage through 'em, since the Blood drawn from the *Ventricle*, as it enters into the Heart, has quite another colour and consistence than the Blood that is drawn from the *Aorta*, as it proceeds from the Heart. All Anatomists in general ascribe the Cause of this change to the Air, drawn in by Respiration, but they very much differ in their Opinions concerning the manner how the Air works this effect, and procures to the Blood this florid colour as it passes through the Lungs: I shall only observe what will make for my present purpose, that the chief end of Respiration is by the pressure of the Air, to change the Blood, so broken and divided, into round Globules again, and that the Heterogeneous Parts, as the Chylous, Sanguineous, Lymphaticks, which constitute the *Venal Blood*, should be reduc'd into one entire Mass. From this Account, we may the better understand the reason why the least Distemper of the Lungs, when the Respiration is perform'd with any difficulty, that the Body grows faint and languid, and the Parts consume for want of Blood proper for their Nourishment. As for Example, supposing a Cold obstructing the passage of the Air through the Nose, and that from the same Cause the *Amigdales* swell and lie heavy upon the Throat, and that in Inspira-

F

tion



tion the Air does not so freely enter into the Lungs as sufficiently to compress the Blood; in those Cases the Blood is very waterish, and the Mucilaginous Parts will swim on top, and constitute a white *Pellicle*. In like manner in case of a Pleurisy, when the *Musculi Inspiratores* are ill affected, as not to dilate with ease, and raise the Ribs without pain, for the admittance of the Air, the effect will be the same, and the Blood is as much dissolv'd in Pleuritick Persons. Lastly, We may account for one sort of *Agues*, which most frequently happen in the Spring-time, when the Air, and our Bodies too, abound with more than ordinary moisture; whereby it happens that the Parts, serving for Respiration, cannot rise and fall, and move easily, and the Air having lost its Spring and Elasticity, has not force enough to dilate the Lungs, and fill the airy Vesicles. If then it is reasonable to suppose, the Blood is considerably alter'd in its texture from its passing through the Lungs, and what was loose and disunited becomes firm and compact, we shall quickly find a reason for the *Right Ventricle* being more capacious than the *Left*.

But since this may be thought a meer Supposition, and not a Satisfactory Answer, to the Objection before us, we shall not wholly rely upon it, and still supposing one *Ventricle* is larger, than the other, (which admits of a Dispute) then it may be said, that considering some waste the Blood sustains in its passage through the Lungs, it may be imagin'd the *Left Ventricle* may easily contain the remainder; but which way the Blood comes to be diminish'd in its quantity, before it arrives to the *Left Ventricle*, is to be prov'd, and tho' there may be several assign'd, yet

yet the chiefest is that after the Blood has pass'd from the *Right Ventricle*, and arriv'd at the extremity of the *Pulmonary Artery*, a great part of its Serosity, after it has been serviceable to the forming of the Globules, is convey'd into the *Lymphaticks*, to be convey'd back again into the *Vena Cava*. That Opinion, I confess, will have no place here, which supposes that a great part of the Blood, sent into the Lungs from the *Right Ventricle*, is spent upon their Nourishment, since we may very well imagine that the Blood, while contain'd in the Lungs, is as unfit to nourish 'em as that contain'd in the *Ventricles*, and that brought by the *Porta* into the Liver is incapable to nourish those Parts; and when Nature has for that purpose supply'd the Liver with the *Hepatick Artery*, the Heart with the two *Coronals*, why mayn't we conclude that the *Artery*, found out by that Accurate Anatomist Dr. *Ruyfch*, is design'd for the Nourishment of the Lungs?

What the *Antic.* next Object, That there is a great disproportion between the two *Auricles*, and consequently the *Circulation* cannot be constant and regular; I grant 'em the first Part, and a great deal more, that the difference between the *Auricles* in their size, is much greater than between the *Ventricles*, yet their inference is very false, occasion'd from not truly considering the right Use of the *Auricles*, for they suppose that they are either the measure of the *Ventricles*, or that they beat once or twice to the *Ventricles* once; but neither ought to be admitted, for since we are assur'd that in Fishes, and amphibious Creatures, whose *Auricle* we generally find to be four times as big as their *Ventricle*, the *Auricle* can-



not be the exact Measure of the *Ventricle*, but must keep back three Parts, and send no more than what the *Ventricle* is capable to receive. So likewise we conclude, since we see the *Ventricles* in other Animals much larger than their *Auricles*, and that the *Ventricles* can contain two Ounces, when the *Auricles* can contain but as many Drams, and that the *Ventricles* send into the Lungs a greater quantity of Blood than can be supply'd from the *Auricle*, that therefore the *Auricle* is not the Measure of the *Ventricle*, nor shall we find that this defect in the *Auricle* is supply'd by its pulsing twice or thrice to the *Ventricles* once, because if there is Credit to be given to our Senses, we observe quite contrary in Dissections, that the motion of the *Auricle* answers to that of the *Ventricle*, and the contraction of the *Auricle* always precedes the dilatation of the *Ventricle*. *Harvey* says the *Auricle* moves before and after the Heart, from which expression the *Antic.* have form'd a very fallacious Argument, to prove it was *Harvey's* Opinion that the *Auricles* puls'd twice for the *Ventricles* once, since the motion of the *Auricles*, after the *Ventricle*, is only a Preparative for the *Ventricle's* pulsing after the *Auricle* again: Since then we neither allow the one to be the Measure of the other, or that one is oblig'd to pulse thrice to the others once, we need only say that the Office of the *Auricle* is not to receive all the Blood which comes by the *Vena Cava*, or that it all passes through the *Auricle* before it enters into the *Ventricle*, but only to lodge that Portion of it which flows from the Vein in the time of the Heart's contraction, and which therefore cannot be receiv'd into the *Ventricles*, its *Valves* closing together

gether and obstructing the passage into it, but then as soon as the Contraction is over, the *Auricle* in its turn propels that superfluous Blood which it contain'd into the *Ventricle*, which then begins to dilate; in which state the Blood still flowing from the *Vena Cava*, finding the door of the *Ventricle* standing open passes directly into it, till such time as a sufficient quantity has been receiv'd, so as to fill the Capacity of the *Ventricle*. Then the Heart begins to contract again, and the *Valves* of the *Ventricle* at that time, by a sort of Mechanism (as shall be shewn in another place) oppose the Blood, which finding no admittance, is constrain'd to pass into the *Auricle*, till the *Ventricle* has the second time discharg'd the Blood by its Contraction or Pulsation.

From a knowledge of the right Use of the *Auricles*, we may easily understand for what reason Nature has supply'd the *Right Ventricle* with a large *Auricle*, and the *Left* with a very small one; for since the Blood returning by the *Vena Cava* to the *Right Ventricle* moves slowly, tho' it flows continually without intermission, a large *Auricle* is requisite as a *Diverticulum* for the Blood, that there might be some in a readiness, till the Dilatation of the *Ventricle* begins. Had there not been this Repository to reserve the Blood in, it would be impossible it should rise fast enough for filling the *Ventricle* before its Contraction begins; and therefore Fishes, and amphibious Creatures, have an *Auricle* four times bigger than their Heart, because their Blood is, if not actually, yet in comparison of other Animals, extremely cold, and consequently their Blood circulating very leisurely, it could not reach in time to the Heart,



Heart, but be very tardy, had not their *Ventricle* been supply'd from the Blood which their large *Auricle* keeps constantly for future necessities.

This being one of the Reasons why we find a large *Auricle* prefix'd to the *Right Ventricle*, we shall quickly see that the *Left* has occasion but of a small one, because the motion of the Blood is very swift through the Lungs, occasion'd by the Air in Inspiration, and is sent in a sufficient quantity, and perhaps by jerks into the *Left Ventricle*; and because the *Pulmonary Vein* is perpendicular in respect to the Mouth of the *Ventricle*, and exactly opposite to it, it may then very well be said, that the *Left Ventricle* has no other occasion for an *Auricle*, *Sed ut Sanguini pretereunti motus fortior imprimatur.*

Much of the same Nature is the next of the *Antic. Objection*, viz. That since the *Veins* are much larger than the *Arteries*, particularly the *Emulgent Artery* answers but to a third part of the Vein, it would be impossible they should fill each other, but the *Veins* would in some time receive the Blood in the whole Body into themselves.

In answer to that Objection it may be said, That tho' the *Veins* are larger than the *Arteries*; nay, tho' it is as certain, that in the Body there is a majority of *Veins*, and many more than *Arteries*, yet we have no reason to fear any ill consequence from thence, or that it would be any difficulty to make out the *Circulation* according to that Supposition, for tho' the *Veins* exceed the *Arteries* in bigness, yet what these lose one way they make up another; the Bloods motion in the *Artery* is swift and nimble, but the *Venal Blood* moves slow and leisurely.

The

The Doctor, to prove what ill Consequence would attend the *Circulation*, supposing the *Veins* to be bigger than the *Arteries*, makes an Experiment with two Cranes, whose bore will bear the same Proportion to each other as the *Veins* to the *Arteries*, and plac'd into two Vessels of Water of equal Size and Measure; and the larger Crane; when set on running, will draw all the Water from the less.

I can't tell what might be if the larger Crane could be made to run, but I very much question the Matter of Fact, and am perswaded that the largest Crane will be so far from drawing the Water from the less, that neither of 'em will draw at all; since these Vessels are of equal Size and Measure, the Air in one Vessel has as much to resist the falling of the Water, as the Air in the other Vessel has to make it rise. If there had been less Water in one Vessel than the other, the running might continue till the Water in both Vessels are in one *Equilibrium*, when it will afterwards remain in that state.

I shall yield to the Doctor in this Point, since he says he has try'd the Experiment, and shall only take notice, That as the *Veins* and *Arteries* have unequal *Drameters*, if the Blood should likewise have the same Compression in the *Veins* as well as the *Arteries*, it would be impossible that those two Vessels should constantly fill one another, but that the *Circulation* must be interrupted: But here lies the difference between the two *Cranes*, and the *Veins* and the *Arteries*, That in that Experiment the Air equally compresses the Water that is to rise by the large Crane, as well that which is to rise by the small one, and therefore different quantities of Water will flow from both  
the.



the *Cranes*, according to the Proportion their Orifices bear to one another. But tho' the Veins are twice as large as the Arteries, yet if the *Arterial Blood* be twice as swift as the *Venal*, the same quantity will run out of one as the other, and the *Vein* will be the exact Measure of the *Artery*. This Proposition may easily be understood, by the help of Natural Reason, without the Assistance of any other Mathematicks, and therefore shall proceed to examine the next thing, in the *Circulation* which the *Antic.* can't be reconcil'd to, and that is, the Doctrine of Contraction and Expulsion, blaming *Harvey* for his odd expression, that the Heart brings forth the Blood from the *Vena Cava*, by the drawing of both its *Ventricles*, and so by its pulsation and motion transfuses it into the great *Arteries*.

This had been a strange Explication of it, and altogether unworthy of so great a Philosopher, and an Ingenious Person: But before we lay an Accusation against him, 'tis but fair and equitable first to enquire, whether or no he is guilty of an Expression which leaves the Subject he would explain, as unintelligible as if he had said nothing. I find he is so far from conceiving any such thoughts upon the Matter, that he very often teaches quite contrary, particularly in his Second Chapter, *Sanguis ingreditur In ventriculos non attractione aut distinctione cordis sed pulsu auricule immissus*, That the Heart and *Ventricles* too are Passive in the dilatation, and receive the Blood without drawing, or any faculty whatever, but that by the Contraction of the *Auricle*, what Blood it contain'd is propell'd into, and dilates the *Ventricle*. This Opinion is an Antagonist, and quite opposite to that  
of

Drawing, and yet *Harvey* made to be the Author of both: This is agreeing with the Laws of *Circulation*. and therefore seems to be the true Judgment of *Harvey* about the Matter, but by the other he not only contradicts himself in several places, but the Notion is as imaginary as any the Astronomers make use of to exprels the motion of the Planets; besides that, all Anatomists in general confess, with one mind, that the Heart acts not at all in its dilatation, but that its proper action consists in the Contraction. How then could *Harvey* make use of the several Faculties, since what they signify might, in his Judgment, be better explain'd by a way far more natural and intelligible? How could he be guilty of so gross a mistake, as in one place to affirm, that the Efficient Cause of the *Ventricle's* filling with Blood was some attractive faculty, and in his Third Chapter quite alter his Mind, and declare, *Quod ventriculi extenduntur ab hoc quod illis immittitur*. There is no necessity to ascribe any action at all to the *Ventricles* in their dilatation, they need but suffer themselves to be distended, to receive the Blood which flows in 'em with great ease and facility. What relates to their Contraction and Expulsion afterwards, we shall understand by Answering their next Objection; and that is, If the *Ventricles* fill like Sackes or Bags, why do not they empty themselves too by running over, rather than induce such violent means, as pulling in their Fibres to expel the Blood?

If, indeed, the Doors of the *Ventricle* stood continually open, to admit the Blood from the *Auricles* and the *Veins*, and supposing on that the same motion should be in the Blood, (which is impossible to



comprehend, without allowing the Contraction and Expulsion of the Heart to force the stream along, and drive the torrent with rapidity) there might be reason to imagine, that after the *Ventricles* have receiv'd a quantity sufficient to fill 'em, that the rest should pass of its own accord into the *Arteries* without the Contraction of the Heart. But if we consider, that after the *Auricle* has sent the *quantum* it contain'd into the *Ventricle*, and the Overplus is supply'd from the *Vena Cava* till such time as it has been sufficiently dilated, then the Heart, as all the other Muscles of the Bodies, when they are stretch'd, seeks to recover its Natural state of Contraction; and if we farther consider what happens to the Heart at that time, we shall have no cause to suspect that a too great flux of Blood should so much Master the spring and force of the Fibres of the Heart, and distend it beyond the power of restitution. There is so little fear of such an ill Consequence from the Bloods rushing into the Heart, considering its bulk, the strength, and various disposition of its Fibres, and the small *Auricle* prefix'd to the *Ventricle*, that instead of over dilating it beyond Measure, 'tis much more difficult to conceive how the Blood should ever dilate it at all; how it should overcome all those difficulties and oppositions as to gain any admittance. And lastly, That the Contraction of the *Auricle*, so small in comparison of the *Ventricle*, should be able and potent enough to open the door of the *Ventricle*, so strongly fortify'd and barricado'd. But since it is what was not objected by the *Antic*. I am not oblig'd to put Objections into their Heads: What I shall remark at present is, That

That when the *Ventricles* of the Heart have been fully dilated, and being molested by the expansion of the Blood, they call the Animal Spirits to their assistance from the Brain; which being sent into the Fibres of the Heart cause this effect, to bring their Ends nearer to their Center, and the *Cone* of their Heart to the Basis; the sides then of the *Ventricles* approaching to one another, must consequently, being streightned, thrust the Blood into the *Arteries*. And as in the *Systole* of the Heart the *Cone* is brought upwards near the Basis, we must acknowledge that the tendinous Fibres, which are fasten'd to the *Valves* of the Veins, and dispos'd from the *Cone* of the Heart to its *Basis*, must in the abbreviation of the Heart relax and slacken their Reins, whereby the *Valves* themselves, to which they were affix'd, being loose in the beginning of the *Systole*, are driven upwards by the compression of the Blood, and shut the door of the *Ventricles* to which they belong, so exactly, that not one drop of Blood can be admitted from the Vein, or what is contain'd already in the *Ventricle* pass any other way than by the *Arteries*, whose Orifice stands open. So when the Heart is prolong'd, that its tip recedes from the Basis, these *Valves*, and their tendinous Fibres, and the fleshy Columns, are drawn down and flat upon the sides of the *Ventricles*, that the Heart might again, by a new flux of Blood, be again dilated. But by the way, considering the strength of these *Tendons*, and their crossing from the *Ventricle* to the *Septum*, we may conclude that one of their uses is to prevent a too great and extravagant dilatation. Tho' it be true what the *Antic.* say, that Dr. *Tauvrey* did affirm, That the *Ventricles*, if



they were dilated from the bare flowing in of the Blood into 'em, their *Fibres* would be stretch'd beyond their tone, and the Heart keep always distended; yet it is plain, from the Thread of his Discourse, that he is to be understood as in opposition to those whose Opinion is, That the Spirits ought to be excluded from any Office, or bearing any part in the action of the Heart, that as it dilates without their assistance, so the whole power and virtue of Contraction is in and from its self, without any dependance from the Spirits: After the same manner as a twig of a Tree pull'd down beyond its natural scituation, will fly up again, as much beyond its poize, and continue a vibration for a considerable time.

But the *Antic.* continue still to Object, That the *Valves* can never be design'd to hinder the return of Blood into the *Veins* and *Auricles* during the Hearts *Systole*; and if the pretended *Nerves* can shut and open the Heart, what are the *Valves* for shutting and opening of it, and letting things out at every Pulsation? And therefore 'twill be requisite to observe to 'em, that the *Valves* have no relation to the Efficient Cause of the rising or falling of the Heart, but it is by an accident from the Contraction of the Heart, that they so exactly shut the door of the *Ventricles*, and hinder any Blood from passing by.

There lies at the Basis of the Heart four large Vessels, viz. Two *Arteries* and two *Veins*; at the entrance of 'em into the Heart they have obtain'd *Valves*, arising, according to *Bartholin*, from the expansion of the *Tunics* of the Vessels, whereunto they belong; and, according to *Steno*, from the small *Tendons* that are joyn'd to the internal straight  
Fibres,

Fibres, situated in the internal Surface of the *Ventricle*.

These *Valves* are otherwise dispos'd in the *Veins* than in the *Arteries*, in those they are *intra spectantes*, but in these *extra spectantes*, from which we guess at their different purposes: These four Vessels have the same number of *Valves*, except the *Pulmonary Vein*, tho' they have different Names according to their different resemblance and figure, those in the *Veins* being call'd *Tricuspides* and *Mitrales*, and in the *Arteries*, *Sigmoides* and *Semilunares*. The Reasons that are assign'd, why Nature has furnish'd the *Vena Pulmonaris* with but two *Valves*, is because its figure not being round as the other Vessels, but oval, may more exactly be clos'd by two than it could be by the juncture of three. The situation of these *Valves* shews evident for what use they are for, and that the design of their formation was to prevent that the Blood, thrust into the Heart by the *Auricle* and *Vein*, should by the constriction of its *Ventricles* be expell'd the same way as it came in, but the looking inwards of the *Valvula Tricuspides* was to permit the easie sliding of the Blood into the Heart, and to prevent, by their rising, that the Blood might regurgitate into the *Auricle*, but be constrain'd to seek for an *exit* by the *Arteries*, whose orifice at that time stands open, and free for its passage. But because that in the contraction of the Heart the Blood must of necessity press hard against the *Valves*, and there had been cause to fear least the force of the Blood should break those Membranes, Nature has therefore fortify'd 'em with strong and numerous Fibres, especially those of the *Left Ventricle*, that they might  
not



not only resist the impulse of the Blood against 'em, but also contribute to its expulsion by the *Arteries*. Notwithstanding the strength of the *Valves*, and the *Tendons* united to them, Nature has taken farther care that it might not be left in the power of the Blood to make too great resistance, and force the *Valves* beyond what they are able to bear, and therefore the Blood flowing continually towards the Heart, and finding no admittance, much of necessity press upon the *Valves* which oppose its entrance, and by its weight upon them does in a manner counterballance the pressure and opposition of the Blood from within. What the Action and Office of the *Valves* is, may farther be discern'd by an Experiment made at *Amsterdam*, and is thus reported by *Bartholine*; That having open'd the *Right Auricle*, and blowing by the *Arteria pulmonalis* swell'd the Heart, it was observ'd that a passage of the Air into the *Vena Cava* was intercepted, by the rising of the *Valves* of that *Vein*: And afterwards having cut the *Left Auricle*, and swell'd the Heart by blowing through the *Arteria Aorta* into it, the *Valves* of the *Pulmonary Vein* fill'd like Sails with Wind, and gave no passage for the Air by that door into the Lungs. From this Experiment we may be convinc'd of the Error of the Ancients, and several of the Moderns, who imagin'd, that as the Blood flow'd into the Heart, that the *Valves* could never so entirely joyn as to hinder the relapse and return of the Blood back again: But they may be farther convinc'd of their Error, by tying with a Ligature the *Arteries* above the Heart, and then observing the fulness of the *Arteries*, and how empty the *Veins* are towards the Heart, it is a demonstration

tion there can be no reflux of the Blood into the *Veins*.

This brings me to an Objection of the *Antic*. That tho' the Contraction and Expulsion of the Heart is maintain'd, yet the *Circulators* could never account for that impetuous motion of the Blood up the ascending Trunk of the *Aorta*, as to be convey'd into the remotest Parts with equal force and vigour.

To this it may be answer'd, It is so far from being a Wonder, how the Blood should ascend so fast and quick into the Superiour Parts, that according to Dr. *Lower*, the Blood *Circulates* with greater celerity through them, and returns sooner to the Heart, than from the Inferiour Parts of the Body; and he gives this Reason for it, *Sanguis à Superiore Corpore facile in Cor defluit, Cum autem ab inferiore parte agresse sursum urgetur*. And therefore the Supposition is false, that the Blood *Circulates* with equal force and celerity, as fast through the Extremities as through the Vessels near the Heart; *Pulsus Systolen & Distolen, non dico in omnibus vasis Sanguinem continentibus eandem est sed talem & tantam in omnibus ut exinde circulatio fiat*, says *De Baek*. But as to their Objection, we may easily explain the Reason why the Blood should be sent upward into the ascending Branch of the *Aorta*, if we consider with what great force and violence the Blood will gush out of a cut *Artery*, and to a great height; but yet it will appear more plain from the reason why heavy Bodies, such as the Blood is, should sometimes act contrary to their own Nature, and move upwards. I shall let alone inquiring, whither there is an Intrinsic Gravity in Bodies, and what may be the reason why some take a  
contrary



contrary course to others, it is sufficient for my purpose to observe, That supposing an Ounce of Blood to be expell'd the Heart at every Pulsation, it must have a space proportionable to its bulk to move in: Suppose then the Blood discharg'd from the *Left Ventricle*, naturally inclines to pass all by the descending Branch of the *Aorta*; yet being in too great a quantity to be admitted, it must necessarily keep moving, *Qua data Porta*, and be constrain'd to ascend contrary to its inclination, if it be where no hard Bodies interposes to divert its course. In like manner, that when we strike with a Stick upon the Surface of any Water, many drops will rise with force contrary to its Nature; and the faster any Liquor boils, the sooner will it ascend and run over, since upwards there is nothing to obstruct its course, but in moving any other way it meets with impediments from the bottom and sides of the Vessel that contains it. But we shall have reason to think the Bloods motion upward may be done with great facility, from the Observations we shall make upon their next Objection, That if the Heart was suppos'd to be able to throw the Blood into all the Parts of the Body, Superiour and Inferiour, the force and strength of the Heart must be equal to the whole Mass of Blood, so as continually to drive it round the Body; which is incredible, that it should overcome so great resistance.

We may very well answer, That supposing twenty Pound of Blood in our Body, or twenty five, which is the largest computation, there is no necessity that the force of the Heart should be equivalent to the whole Mass, and should be imagin'd the only Agent in the Bloods motion; for tho' we grant it the principal

cipal, yet that is not the only Instrument of the Bloods motion. In the *Systole* of the Heart, when the Blood is sent into the *Arteries*, as there are several Causes concurring to help it forwards, so one is the constriction of their backward Fibres, as is plain from the Experiment of tying an *Artery*, that no Blood can pass from the Heart beyond the *Ligature*; and then we shall observe, in the time that the Heart makes two or three Pulsations, that the *Artery* above the *Ligature* will be turgid and swell with Blood, when that part below it will be quite empty, the Blood having pass'd, as usually, into the *Veins*. And since it is apparent, that the Blood below the *Ligature* can have no force, communicated from the Heart, to drive it along, then, consequently, that we find the *Artery* empty, is wholly owing to its Longitudinal and Circular Fibres, which cannot act but must press the Blood on all sides, and force it forwards. We may likewise add, After the Blood has, by passing thro' the Body, deposited in different Parts the *Menstruum* homogeneous to their Contexture and Composition, that then those Parts do, by a Spring and Elasticity, protrude the Blood, and help forward its return to the Heart, in order for the obtaining new qualifications requisite for their future nourishment; particularly, the Muscles by compressing the Blood-Vessels, contribute much to the *Circulatory motion* of the Blood, and make its Ascent from the inferiour Parts of the Body to the Heart, more easie and expeditious, since by the *Valves*, and their order in the *Veins*, it is supported, and kept from falling by its *pondus* to the extremities back again. But what need we seek for an adequate, and sufficient Cause, to preserve this *Cir-*



*culatory motion* of the *Blood*, if it be true what *Borelli* delivers concerning the Heart, *Vis motiva musculi Cordis fibrarum, per se Considerata, majus pondus suspendere posset quam 3000 librarum.* And again, *Vis motiva musculi Cordis superat suo momento resistantiam totius Sanguinis, arteriarum, & fasciarum earundem dilatationem impredientium quæ major est vi ponderis 18000 librarum.* Suspending my Judgment about the truth and reality of these Assertions, the manner of his proving it seems to carry a great shew of probability along with it: But the *Antic.* will not be perswaded of this, till they are convinc'd of the Hearts being a *Muscle*, which they say no one has prov'd; and Dr. *Lower* seems to be very dubious about it, and leaves the question undecided.

There are two Reasons for which they can't consent to the Hearts being a *Muscle*: One is, because they never could discern any other than fleshy *Fibres* in the Heart; and the other, because the Heart moves not only without, but against our will, and therefore is not the Instrument of *voluntary motion* as *Muscles* are defin'd to be. Now it seems strange that the *Antic.* who adore *Hypocrates* in every thing else, and maintain his Hypothesis of the *Bloods* motion, should dissent from him in what he was most in the right, when he says the Heart is a very strong *Muscle*; and since the Sentiment of *Hypocrates* has been confirm'd, by observing in the Heart no other *Parenchyma* than what consists of curious order, and disposition of *Fibres* variously interwoven and contriv'd, for the expulsion of the *Blood* through the whole Body, the termination of 'em into *Tendons* at the Margin of the Heart, and a great quantity of *Nerves* dispers'd  
over

over it so different from the fleshy *Fibres*, that by their white colour they may be easily dissected and trac'd distinctly from them. In short, by displaying the Heart, and comparing it with the other *Muscles* of the Body, we shall find that nothing will be wanting to it that is necessary to the formation of a *Muscle*; and there goes nothing more to its composition than what may be found in the Heart, as *Veins, Arteries, Nerves, Fibres, Membranes, &c.* Dr. Lower is so far from making a scruple of it, and saying what the *Antic.* would have him, that from considering the structure of the Heart he asserts its Musculosity: *Qui quidem Machinae apporatus certo demonstrat ipsum plane Musculum esse, motumq; reliquis musculis similem sortiri.* And tho' it be true, as the *Antic.* observe, that *Walleus* denies the Heart to be a *Muscle*, yet since he allows it by virtue of its *Fibres* to have the same action with, and to contract as all the other *Muscles*: And since he accounts the same way for the motion of the Heart, as he does for theirs, I see no reason why he should exempt the Heart from the number of *Muscles*, especially considering that it is not essential to a *Muscle* that it should always act with the consent of the will; and this will not appear difficult, if we consider that the Blood and Spirits together may be sufficient to cause a motion in some of our Parts, without our knowledge, as they do Nutrition, which is made in us, without waiting for a order from the Will, since we do not so much as perceive when it is done. No one will deny, but that the *Muscles* of the Arms and Legs are true *Muscles*, yet how often do they act without any command from the Will, as upon a sudden surprize or



fear of falling, and to prevent an Accident? Their action is done, if not without the consent of our Will, yet with Inadvertency, and without our taking notice of it. What then if we say, That every Pulsation of the Heart is depending from, and govern'd by the Will, yet because of the continual influx of the Animal Spirits into the Heart, the Nerves are thereby render'd more pliable, and the Muscle moves with greater ease and facility by this habitual Exercise, and that is the reason we are not warn'd of every motion of the Heart, and from the constant Practise of it, become less sensible of its working, tho' we can't say that it is out of our power to determine or alter the motion of the Heart, since in doing any thing which may create either Pleasure or Grief to us, we easily perceive the Pulsation to be alter'd according as we entertain an impression of either of those Passions in our Minds. If none of these Reasons can satisfie the *Antic.* why the Heart ought to be reckon'd among the Muscles, we have but this to observe farther, That either the Heart must be look'd upon as a Muscle, *in sua specie*, and distinct from the rest, or else confess with Dr. Glysson, *Fibræ motui musculorum dicatas, ab aliis causis, quam ab imperio voluntatis aliquando posse immediate excitari.*

The next Objection is, That after the *Circulators* have done all they could, and made a long *Apparatus* to prove the Heart a *Muscle*, yet what need is there for its being so, since the Lungs are not Musculous, yet they move, rise and fall, keep pace, and correspond with the motion of the Heart, which may move as well as they without being Musculous? To this I answer, That it is agreed on all hands, and

no

no one disputes it beside themselves, that all the actions and motions in our Bodies are perform'd by the help of *Muscles*; and if the Lungs are destitute of 'em, they ought to be esteem'd as wholly Passive in the Respiration. But because *Respiration* signifies a successive and alternative dilatation and constriction of the *Thorax*, occasion'd from the coming in and going out of the air; and as this action is meerly Animal, it is then to be perform'd chiefly by Muscles, which are the Instruments instituted to move the Animal: And tho' the Lungs are not Musculous, yet Nature has appointed Muscles to perform the action of Respiration; some whose Office is to dilate the Breast, to the end that the Air might enter into the Lungs, and those are call'd *Inspiratores*: And some others which serve to expel the Air, by squeezing and thrusting it out of the Lungs, and these are call'd *Expiratores*. If we consider the disposition of the Ribs, that their Articulations, with the *Vertebræ*, are by a double *Artbrodia*; and that the Ligaments which fasten 'em in their Articulations, both to the *Vertebræ* and *Sternum*, are both strong and short, we shall find that the only motion which the Ribs can have, is to ascend and descend; and that several Muscles, which have been allow'd for the abduction of the true Ribs, cannot serve for that action. What Muscles Anatomists have thought serviceable to the ascension of the Ribs, in Inspiration, are very numerous; but those whose action is most visible at that time, are the *Intercostales*, the *Serrati postici Superiores*, *Levatores Costarum*. Those call'd by *Diemerbroeck*, *Cervicales descendentes*, *Serrati postici inferiores*, and the *Diaphragm*; which last is one of the chief that



that help the Inspiration, as its situation shews evidently for what use it is design'd. 'Tis acknowledg'd to be a Muscle flat and large, ty'd to the second *Vertebra* of the Loins by two strong *Tendons*; to the Inferiour Parts of the *Sternum*, and the *Cartilages* of the Bastard Ribs, by its fleshy circumference: Its middle, which is tendinous, is suspended in the middle Part of the Heart by the *Mediastinum*, whence proceeds its concavity towards the Belly, and its gibbosity towards the *Thorax* upon the Lungs. From this situation, we see that the Muscular circumference contracting, the middle is drawn down, and from a Convex laxity it comes to a plain, which makes the cavity of the *Thorax* abundantly longer and larger. These are only some few of the Muscles that serve in the Inspiration, and which in their acting produce these two effects: First, By raising the Ribs, and by enlarging the Cavity of the *Thorax*, whereby the Atmosphere being press'd, the air is oblig'd to come round and enter by the *Trachea* into the Lungs, to fill up a space equal to what it did before. If by any accident a free passage for the air into the Lungs is obstructed, or the air any way intercepted, it is impossible to raise the Ribs, because the external compression of the air would hinder and over-power the Force of the Muscles. When once the action of Inspiration is over, *Borelli* imagines that the oblique situation of the Ribs, the natural spring of their *Cartilage*, and the weight of the *Sternum*, are alone sufficient to cause the Expiration, after that the Cause, which brought up the Ribs, was remov'd. But tho' these Parts have a great strength, and work powerfully to perform that action; and tho' likewise the disposition

disposition and action of the Muscles of the *Abdomen*, by their Contraction, and pressing the *Diaphragm* and *Bowels* upwards towards the Lungs, do in a great measure contribute to the expulsion of the air, and promote Expiration; yet why mayn't we say that the Lungs themselves bear a great share in that Office? For as soon as the air contain'd in the Lungs is put into motion by the Organs of Expiration, the ligaments and fleshy *Plexus*, describ'd by *Malpighius*, which embrace the aery *Vesicles*; and the Muscles of the *Trachæa*, by their natural spring, contracting and squeezing the *Vesicles*, oblige the air to turn out. I suppose, what has been said, is enough to convince the *Antic.* that the Respiration being an Animal action, is perform'd by the assistance of the neighbouring Muscles, tho' the Lungs are without any. Now since the *Antic.* immediately after this last Objection, were resolv'd no longer to beat and play us with great Guns, as their expression is, there only remains some Scruples which they desire to be satisfy'd in, before they will embrace the *Circulation of the Blood*.

The first Question is, How comes it to pass, that since the force of the Heart is so extraordinary, we are not sensible of the passing of the Blood into the *Arteries*?

There is certainly great reason why our Minds should not be taken up continually with the thought of an action, the knowing of which does not at all concern us: And if we look upon the Body to be only as a noble Piece of Mechanism, curiously contriv'd and divinely fashion'd, we shall find great reason why the Wise Author of Nature should give such Laws of Motion to our Parts, and such a sense of their action



as is most agreeable to preserve our whole Body, without permitting that our Mind should be perurbated with the incommodity of perceiving the action of the Heart and Arteries, and Fibres, which would occupy it too much, and hinder it from being sensible of the impressions of Pleasure and Pain; besides that, the perpetual attention the Soul should give to these inward actions of the Body, would take us off from having a sense of the external Objects. Why should we perceive the passage of the Blood into the *Arteries*, or the expulsion and contraction of the Heart, altho' it be made with great force, when we are not sensible of the action of the Stomach, Guts, Brain, Ureters, Muscles, and many other Parts of our Body which are as strong, and their motions rather more violent than that of the *Heart* and *Arteries*? Besides that, the *Arteries*, tho' after their *Systole* they are in some measure contracted, yet they are not so close, but give a free admittance of the Blood into them, when the case is not the same in the *Spincter* of the Bladder, which is kept constantly and exactly shut, that no *Urine* can pass, or the *Spincter* be dilated, till the *Fibres* of the Bladder, acting as an Antagonist to the *Spincter*, opens a free passage to the *Urine*. The *Antic.* have no reason to say that we have no sense of the Bloods motion, since they may be convinc'd, by applying their hand to the Wrist; and then they Judge with what celerity the Blood moves in the *Arteries*. But then, in a preternatural State, Dr. Lower relates a very remarkable Story, That the Heart did strike so vehemently, and with such a force against the Ribs, as to break 'em; and that the contraction of the Heart, was heard from the Chamber into the

the Street, by those who at that time were walking by. And tho' in a Natural State, the Actions of our Bodies are perform'd without any disturbance, yet upon the least disorder in any Part; as for example, when it is inflam'd, or some fire has divided the Fibres, we shall be sensible of the Pulse in that Part, and the beating of the *Arteries* against it will cause an exquisite sense of feeling, and be accompanied with great uneasiness.

They desire to know a Reason, Why an Intestine motion, together with a continual supply of Spirits, might not prevent a Putrefaction and Corruption of the Blood, without allowing so swift a *Circulation*.

The best Reason I can give why it is not a sufficient Cause, is, That by the *Circulatory motion* alone, the Blood is preserv'd in a due Mixture and Crasis, and its Similar Parts from separating and dividing. To prove this we may observe, The more violence the Blood circulates with in the *Arteries*, the more firm and associated are its constituent Parts; but as soon as it comes into the *Veins*, the motion being slower, the separation encreases, but when 'tis let out into a Porringer, how soon does the *Serum* separate from the grumous part of the Blood? And we find by experience, that those Persons whose Blood moves slowly, and their Pulse very low, are subject to a *Diabetis*. That the Nitroaereous Spirits, and an Intestine Motion, would not be sufficient for the purposes which the *Antic.* pretend we may gather from a Parallel instance of Water in Marshes, and all Stagnating Water, which tho' they continually receive fresh Supplies from the Rain, and are expos'd to the en-

I

livening



livening Rays of the Sun ; tho' they are continually impregnated with the Nitroaereous Spirits from the air, the same as the *Antic.* suppose to be in the Blood, yet whoever drinks of this Water ill scented and thick, shall have Obstructions in their Belly, hard, hot and distended, and be continually wasted thro' the whole habit of their Body. The same we may say of the Blood, tho' satiated with a continual influx of new Chyle, and the Spirits, which according to the *Antic.* come from the air into us, without a free *Circulation*, it would become feculent, and unfit for our nourishment.

Next they desire to be satisfy'd, Whether all the Liquor we drink does pass through both *Ventricles* before it gets to the Kidnies ? And those who have taken two or three Quarts of Purging Water, and which passes by Urine in a very short time, Whether it circulates with the Blood before it can be separated in the Kidnies, and all without leaving any ill effect upon the Brain ?

We need only say, There is no necessity to have recourse to any shorter way, to account for the quick Seretion of Urine, than from the Liquors passing and circulating with the Blood, since a passage from the Stomach to the Kidnies, has never yet been effectually discover'd. But we may give a very good Reason for a quick seperation of Urine, after drinking some sort of Liquors, without supposing any of that we last drank has yet arriv'd by the Blood, or any other way, to the Kidnies.

In order to the clearing of this, we must examine the Nature of those Liquors which are *Diuretick*, and the Consent there is between one part and another by

by the communication of Nerves. The Liquors that are *Diuretick*, are chiefly of a Volatile or an Acid Nature; and 'tis observ'd that the same Nerves reach from the Stomach to the Kidnies. If we think of these things, it will be plain, that these Liquors are no sooner down, but they begin to prick and irritate the Coats of the Stomach, the Nerves being sensible of the action upon them, draw those of the Kidnies into Consent; whereby being in like manner irritated and press'd, compel the Urine, which they before contain'd, into the Ureters. Another thing which is very probable is, That some of these *Diuretick* Liquors, which we last received into the Stomach, passing in a short time, with the Chyle, into the Blood, having some acidity in it, causes a separation of the *Serum* from the grumous Parts, whereby the Blood being ready prepar'd for the separation of Urine, is oblig'd to stay a very inconsiderable time in the Kidnies before the Secretion is perform'd. After the same manner that Milk, which consists of Parts very like to that of the Blood, is turn'd into Curds and Whey, by the mixture of Runnet, or any other Acid, the Coagulation of the fat and unctuous Parts of the Milk will cause a quick and speedy separation of the Whey and waterish Part: So that the immediate making water after drinking of some sort of Liquors, argues no more, than that the Blood is render'd more loose, and in a manner dissolv'd; that its watry Particles are not embrac'd and kept in by the thicker and mucilagenous, and consequently must discharge themselves by the open passages of the *Reins*, when, on the contrary, an Iscury, or retention of Urine is occasion'd, when the Blood is too much bound and lock'd up in the Vessels,



and by reason of its compactness, does not dismiss the *Serum* with so great ease and facility, but is detain'd a considerable time in the Kidnies before a separation can be made.

We have no reason to fear any ill effect from the passage of those Liquors the *Antic.* speak of, and their circulating through the Head; that part will easily receive an impression and alteration from some kind of Liquors, and none at all from others. There can be no way of accounting how *Pus* collected in the *Thorax* should be discharg'd by the several Secretions of the Body, and come away by Urine, Stool, Spit-  
tle, Sweat, &c. as has been often observ'd, but by supposing it to pass through the Mass of Blood, and yet without any damage to the Parts in its *Circulation*; when at the same time we are sensible of the sudden effect of Wine, and other Spiritous Liquors, and what disorders they occasion to the Brain, when drank too liberally. Our Body may very well be compar'd to a Ball compos'd of several sorts of Metals, which require different Acids to work upon and dissolve 'em: If we mix *Aqua fortis* with Steel, Copper or Tin, the Vessel that contains 'em will grow extremely hot from the violent division of their Parts. The like will happen if we take *Argentum vivum*, but a more perfect Metal, as Silver, will strongly resist the said Caustick, when Gold will absolutely elude its force. So the Parts of our Body have Pores of different Configuration and Size; some may easily admit of the Particles of one particular Medicine, others with some difficulty, and in part only, but the rest not being proportion'd to it, do intirely resist its force and operation. Every Medicine has a peculiar talent  
and

and faculty to work upon some humours more than others ; and we find, that any Purge indifferently taken, unless a respect be had to the Nature of the Disease, and to the humour which predominates in it, will not answer the intention of the Physician. *Mercury* has a quality to affect chiefly the Glands of the Mouth, and very little those of the Stomach and Guts. *Cantharides* either inwardly given, or outwardly apply'd, must of necessity circulate with the Blood, and pass into it by the way of the Chyle, yet without causing any notable effect upon the Blood-Vessels, but retain their virtue to exert it upon the Urinary Passages, which wanting the oiliness and unctuous Parts of the Blood to case and defend 'em, are more subject to the acrimony of their Volatile Salts.

But against what is propos'd, the *Antic.* start a seeming difficulty, That if all Medicines pass'd the long way about, before they came to the Kidnies, they should lose their virtue before they arrive at the part affected, and consequently should have no effect upon the Stone, to dissolve or bring it away.

To this I answer: There being so few *Nephritick* Medicines that are serviceable to the end for which they are given, is an infallible Argument there is no shorter cut for 'em to the Kidnies, than by the way of the Chyle into the common Receptacle, and so into the Blood, and afterward by the emulgent Artery to the Kidnies. But because several have pretended to have had very effectual Remedies for the Stone, still we need not seek for any nearer Conveyance than by the Blood; for tho' the Medicines must undergo considerable changes and alterations, before they reach to the Kidnies, yet what if we say that it is no more than



than what is requisite to render 'em fit for the Offices they are intended for? If, perhaps, they had been apply'd immediately to the Stone which is to be dissolved, they might cause different effects, tho' as far from what we desire, as we now find they do. 'Tis certain, that raw meat is not so fit for the nourishment of our Bodies, before it has been Bak'd, Boyl'd or Roasted; after that it must undergo several modifications before Nature assimilates it, and annexes it to the Parts which is the ultimate term of Nutrition. And so Medicines, by the *Circulating* with the *Blood*, and being alter'd in their passage, are render'd more sanative and healing. We are very sensible that *Linctus's*, and whatever else we give in Distempers of the Lungs, and the Vulnerary Decoctions, can never reach to the Parts that require their Balsamick qualities, but by a long Circumgyration, before they take effect.

One thing why the *Antic.* can't be reconcil'd to Dr. *Harvey's* Hypothesis, is, Because, according to that, the Blood being the Seat of innate Heat, it would follow, from the *Circulation*, that the Extremities would be as warm as the middle Parts, and those near the Heart.

'Tis true, that the Blood is the Seat of innate Heat, and what warmth the Parts enjoy proceeds from the Influence of the Blood: But what wonder is it that the Extremities, where the Vessels are very small, and contain less quantity of Blood, should not have the same degree of Heat, tho' they may be said to have it according to the Proportion of Blood that is in them? And therefore in extream cold weather, by tying a Girdle tight about our Waste, the cold has less

less effect upon the outward Parts, because the Blood not having a free passage in its return to the Heart, continues longer in the *Veins*, and in a greater quantity than usual, whereby we are not so sensible of the cold external Air.

This Objection is easily answer'd, by saying, That the cold acting first upon those Parts which are most expos'd to it, and lie most superficial, the Spirits presently withdraw themselves, or are repuls'd from the circumference towards the Center : The outmost Particles therefore of the Blood being forsaken of that which is the principal efficient Cause of their Heat and Motion, are in a manner condens'd, as it usually happens in Distillations ; if on a sudden the fire is put out, the hot Exhalation which fills the Still is turn'd into a Water. Besides, since all the Parts of the Body, and the Heart it self, borrow heat from the Blood, and the motion which produces this heat is deriv'd to the Blood from the Heart, it will follow that the farther the Blood is remov'd from the Heart, the less degree of heat it will have.

But the *Antic.* are positive that the Proposition is inconsistent, Which supposes that the Heart receives heat from the Blood, and the Blood has its motion from the Heart : And the Reason they give is, Because the Blood having no heat in its self, can dispencc none to the Heart ; and if the Heart borrowed its heat from the Blood, it would likewise borrow its motion from it.

I might mention several benefits the Blood bestows upon the Heart, and other Parts, which it has not actually in it self, and the Heart in return gives other favours to the Blood, and by accident procures it several



veral qualifications which it self is destitute of. Since the *Antic.* allow the Heart to be the chief Bowel for Sanguification, (which Opinion is now exploded) which way can they account why the Heart, which is paler than the Blood, should change the Chyle into so florid a colour, but only by saying, That heat and motion change Colours from pale into red? If then, according to their Hypothesis, they grant that the Heart gives that to another which it has not of it self, why mayn't we ascribe the same Priviledge to the Blood, which tho' of an unactive, yet being put into motion by the Heart, it acquires a heat and warmth, which in gratitude it not only dispences to the Heart, but to all the Parts of the Body; and therefore because Heat is an effect of the Hearts motion, it can't be the cause of it, since it is a Contradiction to imagine that it can be the Cause of one and the self same thing.

The *Antic.* desire to know a Reason, If, according to the *Circulation*, the Blood was driven from the *Left Ventricle* as far as the *Right* again, why it stops when a *Vein* is cut in sunder?

*Answ.* 'Tis true that in small Veins this happens, because the Bloods motion being flow in them, and in a little quantity, the least compression of the Muscles upon the Vein stops the Orifice, and is sufficient to prevent a flux of Blood; but in a great Vein 'tis quite contrary, as appears from a certain *Empirick*, who being to cut off a Vein that grow'd on the Right Side o'th Neck, and not understanding where the *Jugular Vein* lay, by Chance cut it through, and the Patient bled to Death.

Another

Another cutting from the inside of the Thigh a *Schirrus Tumour*, and being ignorant of the Branch of the *Vena Cava*, distributed to the Ham, committed the same mistake, and was the occasion of that Parties death. The *Antic.* may easily be convinc'd, by opening a Dog alive, and dividing the *Vena Cava*, that the whole Mass of Blood, in less than half an hours time, may be drawn into the Receiver: But because they suppose that Blood does but seemingly move along in the Vessels, by the Spirits, as the Surface of any Water by the blowing of the Wind upon it, they may with as much reason say, That in this Experiment too the Blood seemingly runs out of a cut Vein, and the Animal seemingly dies. It would be as plausible as what they say in another place, That the Blood continues to flow from an *Artery*, *ob fugam Vacui*, as the Water rises in a *Syphon*, for the same reason, when it has been sufficiently prov'd that the Blood is sent into the *Arteries* by the impulse of the Heart, and keeps in a constant course from the same Cause; and the reason of the Water's rising in a *Syphon*, has been plainly demonstrated to be no other than from the gravity and pressure of the Air. The *Antic.* are not only content to renew the Doctrine of the Ancients, in opposition to the *Circulation of the Blood*, but likewise trump up all their old and ridiculous Notions, chusing rather to explain things by occult Qualities, than from clear and evident Proofs; as if we were to imitate the *Spaniard* or *North Holland* People, who never change their Customs and Fashions, tho' they should see an apparent Advantage from introducing others.



But if the Blood should run to the Extremities, and return constantly by the Veins, What use is the Ligature for in Phlebotomy, should not the Blood pass freely out of an Orifice, without any help from that? Or, at least, Why might not the Veins swell to a vast bigness, if the Course of the Blood was stopp'd, as not to pass beyond the Ligature?

*Ans.* The Supposition is false, That the Blood will not run without a Ligature, for we very often see the contrary, that when the Ligature is slacken'd, and the Arm is quite unbound, the Blood continues to run out; tho' in this Case, we can expect no more should come than what is return'd by that Vein where the Orifice is made. But by binding the Arm, we find it happens that the course of the Blood is stopp'd in all those Veins that lie Superficial and Exterior, and are liable to be compress'd by the Ligature; and therefore the Blood, being prevented from returning to the Heart, will endeavour to pass where it meets with least obstruction and opposition: And since by the rising of the *Valves*, it is prevented from falling back again, it is easie to conceive that the most natural Method for the Blood in these Vessels to discharge it self, is by passing into that Vein where the aperture is made, and a free *exit* granted to the Blood into the wide World. Nor will it be any difficulty to imagine how the Blood should pass from one Vein into another, if we take notice of the several *Anastomoses* which have been observ'd, and the *Antia* confess they have seen between one Vein and another? But then, Why need we be afraid, lest the Veins, by being obstructed, should swell to a monstrous bigness, for some Veins lie more deep than others,

others, and the Ligature pressing very little upon 'em, can have no power to detain the Blood, or interrupt its passage along to the Heart? But if the Ligature be made so streight about the Arm, as to stop or retard the Blood in those Veins too, then likewise it must of necessity press upon the *Arteries*; and if none, or very little Blood, can go to the Extremities, and the same quantity can but be return'd as pass'd thither by the *Arteries*, what wonder is it that the Veins do not swell, or so much as rise by the Blood which is brought into them?

What Reason can be assign'd, Why the *Vena Cava* beats, when those Veins, which should convey that Pulsation to it, do not beat at all?

*Ans.* This no one can deny, but that there is a visible motion in the *Vena Cava* near the Heart; *Quamdiu ex jugulo vel hepate Sanguis influit*, says *Valæsius*; and 'tis probable Nature would not have bestow'd such strong and muscular Fibres to it, but for the same Reason that the Pulmonary Vein becomes Carneous before it enters into the Heart, that it might be an Assistant to the Blood, and give it a force to overcome the resistance of the *Auricle* and *Ventricle*. This motion in the *Vena Cava* is not deriv'd to it the Long way about, from the Heart to the *Arteries*, then to the interjacent Veins; and lastly, to that part of the *Vena Cava*, as the *Antia* propose, for then it would follow that the other Veins, which communicate this motion to the *Vena Cava*, should partake of it themselves, much more perfectly than that Vein, and their motion be more distinctly discern'd, but we find the contrary. Therefore we may very well say, that



this motion in the *Vena Cava* is principally in its self, from the dilatation and contraction of its numerous and fleshy Fibres, and is partly owing to its being so near, and in the neighbourhood of the great *Artery*, which may communicate a similitude of Pulsation to that Vein, as well as we observe those of the Brain to rise and fall according to the motion of that part, and so in several places of the Body, as particularly in the Arm, where a Vein lies on each side o'th' *Artery*, it is impossible that the *Artery* should dilate, but must necessarily press upon the Veins, and by a motion communicated to them, be an Instrument to drive the Blood forcibly along; and therefore 'tis for this Reason, that the Blood in the *Baslick Vein* runs pretty briskly, whilst the *Cephalick* is seldom us'd by Chirurgeons to bleed in, because as this has no Concomitant *Artery*, to answer that end, so the other has an *Artery* lying exactly under it, and which serves by accident for that purpose.

The next Objection which I intend to Answer, relates to the difficulties and ill conveniences which might arise to the Body in general, but particularly to the soft Substance of the Lungs, from the celerity of the Bloods motion through 'em: To know therefore their sence and meaning about the Matter, they assert, That if according to *Harvey*, and the rest of the *Circulators*, the Blood was strein'd through the Substance of the Lungs so frequently as is generally thought, and with a stream so rapid as is necessary for so quick a *Circulation*, how should it be avoided but that every day *Hæmoptua's* should happen, especially since the pressure of the Air in Respiration would contribute very much towards the breaking of the tender

tender *Vesicles*? Besides, What Reason can be given, why the substance of the Lungs are not as bloody as the Liver?

*Answ.* There's no danger of an *Hæmoptua*, or Spitting of Blood, supposing the Lungs to be in a sound state. Perhaps, by an Injection into the *Pulmonary Artery*, they might have observ'd, that all the Liquor did not pass into the *Left Ventricle* by the Vein, but that some came by the way of *Aspera Arteria*, but we must consider how much the Scene is alter'd after Death; the Body may then best be compar'd to a Looking glass, after it has been breath'd upon, and render'd unfit to shew a Man his natural Face. What obstructions are at that time in the Lungs, how unactive and incapable are the Parts to transmit any Liquor through them, this consideration will remove all cause of jealousy or suspicion, that this accident should happen when the Blood is fluid and spiritous, and may be divided into most minute Particles of a fit Nature to penetrate through the *Vesicles*, which by their natural spring, or tone, are serviceable to the Bloods passage through 'em. The air seems to be so far from being Instrumental in causing any damage, that, on the contrary, the air we draw in Inspiration, very much hinders the Stagnation of the Blood in the Lungs, which would be the only means that could endanger the rupture in any of those small *Vesicles*. Because, that when Life, and the motion of the Parts have ceas'd, we cannot inject Blood from the *Arteries* into the *Capillary Veins*, may we justly conclude, that when the Body is in a Natural State, that the Blood can have no passage from the Extremities of the *Arteries*, into the *Vesicles*.



*Vesicles* which compose the *Parenchyma* of the Parts, and afterwards be renew'd by the Veins again, when all the Parts conspire to force the Blood along, and Respiration, which is the principal Agent, is regularly perform'd, and which exceeds all the artificial blowing by a Pore Bellows into the *Trachæa*, tho' never so much in imitation of the true and natural action of the Lungs? The *Antic.* must always remember, that at the approach of Death, the Body being driven to violent commotions, a great number of small Pipes destin'd for the conveyance of the Blood and Humours, are quite shut up and obliterated; and this will be a sufficient Answer for that part of their Objection. As to the Reason which may be given, Why the substance of the Lungs is not so bloody as the Liver, it may be answer'd, Because there is a great difference both in the Uses they are design'd for by Nature, and likewise in their Composition; tho' both these Parts, as all others, are compos'd of nothing but *Vessels* and *Vesicles*; still the *Vesicles* of the Lungs may be reckon'd to be two sorts, Some have an Office common with those of the Liver, and for the transmitting of Blood, but others are peculiar to the Lungs, and serve wholly to contain the Air, and for the action of Respiration. We may then reasonably infer, since Blood *Vesicles* are not so numerous in the Lungs, in proportion to their bulk, as in the Liver or Spleen, (which of any of the *Viscera* comes nearest to the Lungs in its Composition;) and since why one Part exceeds another in redness, proceeds from a greater quantity of Blood; that therefore the Air in the Lungs gives 'em a paler colour, and takes off much of the redness, which otherwise they would have,

have, according to the quantity of Blood they could contain at once, not what passes through 'em. And therefore in *Embrio's*, who do not breathe, but their Lungs are design'd for future Use and Services, tho' the Mass of Blood does not *Circulate* through 'em, yet they are more florid as well as bigger, in proportion to those in Adult Persons.

If the only Reason why the *Antic.* stick from embracing the Doctrines of the *Circulation*, is, Because its Swiftness is inconceivable to 'em, and they cannot be reconcil'd to the passing of so great a quantity of Blood through the Heart so often, and in so short a time as is imagin'd; if they can any ways prove that the Blood *Circulates* but once in a day, (which will be an hard Task to accomplish) and that few drops only get through the *Valves* into the *Artery* at every contraction of the Heart; and if they will have nothing farther to object against the motion of the Blood, according to *Harvey*, *Lower*, and the rest, I shall readily encline to approve of their Proposal, since it will not in the least weaken or invalidate the *Circulation*.

For tho' there are various Opinions concerning the quantity of Blood which the Heart expels at every Pulsation, and the number of Pulses that are made in an hour, yet tho' all this is uncertain, the *Circulation* is render'd still more evident by the light it receives from what has been said by several Authors, to justify every one his own Opinion. Tho' some suppose the *Circulation* may be perform'd in less time than others who admit but of a very slow one, yet they are all agreed as to the main thing, and allow the *Circulation of the Blood*. *Quod ejus semper redeat labor actus in orbem.*



*orbem.* I shall present the *Antic.* with a short Scheme of the Opinions of some of the most Authentick Authors about the Matter, that they might have several ways to creep in at, and make choice of one among the rest which may seem most likely in their Judgment, and perhaps prevail upon 'em, to come in and acknowledge the *Circulation of the Blood.* 'Tis requisite first to lay down the quantity of Blood suppos'd by these Authors to be expell'd the Heart at every Systole or Contraction, the number of Pulses which are made in an hours time, and lastly compute what quantity of Blood must accordingly pass through the Heart in that time.

	Quant.	Pulses.	lb.	3.
<i>Bartholinus</i>	℥j.	—4400	15	—3
<i>Cardanus</i>	℥j.	—4000	13	—10 $\frac{1}{2}$
<i>Conringius</i>	℥ss.	—2000	3	—5 $\frac{1}{4}$
<i>Diemerbr.</i>	℥j.	—3000	10	—5
<i>Harvey</i>	℥iv.	—2000	83	—4
<i>Lower</i>	℥ij.	—3000	520	—0
<i>Riolanus</i>	℥iv.	—2000	83	—4
<i>Rolsincius</i>	℥j.	—4420	15	—4
<i>Regius</i>	℥iij.	—3000	98	—6
<i>Slegelius</i>	℥j.	—4476	16	—11

Now since it is confess'd on all hands that Pulses vary, and are more or fewer according as the Temperament and Constitution of a Person changes; and since the quantity of Blood, which the Heart expels, and the time in which the *Circulation* may be perform'd, are alter'd by several Distempers, these Authors must have been suppos'd to have Stated their  
Accounts

Accounts according to what comes nearest to the Observations they have gather'd, not from one or two, but many robust and healthy Bodies. We ought likewise to remark, that what those Authors contend for, is, That such a quantity of Blood as is equivalent to that which is contain'd in the Body, passes through the Heart in such a time; not that all the Parts of the Blood circulate with the same celerity, but that near the Heart much oftner and faster than what is brought from the Extremities and Vessels more remote. *Quæcumque Sanguinis Copia aut quantitas fuerit, tantam certe, & toties per Cor circulari,* says Dr. Lower.

If the *Antic.* were to declare their Minds what time they might think requisite to compleat a *Circulation*, we might easily guess which of those Opinions would soonest go down with them. Here are two vastly different from each other, that of *Conringius* and Dr. *Lower's*: And if we allow 25 Pound of Blood to be in a Man's Body, which by some Anatomists is thought too much by Ten, then according to the first of 'em, the *Circulation* is compleat once in about 14 Hours, but by the latter above twenty times in the space of one Hour. The first appears most easie and natural, and seems to remove many dangers that would attend a too hasty *Circulation of the Blood*; but there are stronger Arguments to prove the other most rational, if we take notice how capacious the *Ventricles* are, how much they are observ'd to contain, how often they dilate, and how narrowly they contract to squeeze out the Blood which they had before receiv'd. We may easily foresee an Objection that may be brought against so swift a Circulation, that



by it the Blood would acquire a great heat and fermentation, and cause a Fever to the whole Body. But in the first place, it may be said that Heat is not the Cause, but rather the Effect of a Fever; that a Fever cannot proceed from a Circulatory motion of the Blood tho' never so swift, but from a violent division of its Particles, by the mixing of some Body with it of a contrary nature and quality; and this preternatural Heat continues so long, till either Nature is Conquer'd, or Routs the Enemy. So we may observe, that if Oil of *Vitriol*, and Spirit of *Turpentine*, be put into one Vessel together, a great effervescence and heat will proceed from their mixture; but if Spirit of *Nitre* be added, the conflict will be so great as immediately to produce a flame. But on the contrary, we see that several other Liquors, are so agreeable to one another, and of so mild a disposition, that tho' they are first made hot by the fire, yet by a violent agitation of 'em, they shall be so far from acquiring a greater degree of heat, that they will thereby grow the cooler.

The last Objection which remains to be Answer'd, and which the *Antic* seem to lay the greatest stress upon, is grounded upon some Observations they have made, to prove that a swift Circulation is so far from being necessary for the Preservation of Life, that, on the contrary, Life has continu'd when the Circulation has wholly ceas'd. The form of their Objection is, That if Life depends upon a *Circulation*, and Death immediately ensues upon a stoppage of it, then pray let the *Circulators* declare their Minds, whether, when any one Swoons away, and lies so for above 40 Hours, they think the *Circulation* is all that while

while continu'd : And whether, when the Person recovers, it may be said to be from Death to Life; and if this wont suffice, let 'em answer to the Argument upon Amputation.

*Ans.* In the first Case, 'tis not to be imagin'd that the *Circulation* wholly ceases; a Circulatory motion there is in the Blood, tho' not perceptible, or what can be distinguish'd by the Pulse, because so great a quantity of Blood cannot be sent to the Heart, as really to cause a sufficient dilatation. But because from a deficiency of Animal Spirits, the Heart does not contract with that force, as to be felt beating against the Ribs, must it therefore be said to lie quiet? Because the Pulsation is not continu'd to the Extremities, Must it follow that no Blood is sent thither? We may instance in a Lethargy, when the senses of the Body are lull'd, that the action of the Heart is very weak, and there is no appearance of any motion in the Blood, in any part of the Body : And in a cold Fit of an Ague, when the Pulse is low, and so contracted as not to be perceiv'd by the touch, still we can't affirm that there is a total cessation of the *Circulation* in those Cases; but we find as soon as those Particles which fix'd the Blood are dispers'd, that the same fluidity returns to it as formerly, and the *Circulation* is again renew'd. All this, as well as the Case the Doctor mentions, may be better explain'd from the Account we give them, than by dreaming that the *Circulation* perfectly ceases, which would necessarily infer a privation of Life in the Person, and that the Soul, after it has deserted the Body, should, upon a fresh Summons, return to its former Habitation, and by its enlivening Influences, restore all the Springs



of the Body to their usual motion and operation.

As to the Argument upon *Amputation*, 'tis so far from being a real Objection against the *Circulation*, that it very much conduces to the right comprehending the true motion of the Blood; and is fully convincing, that tho' the *Arteries* and *Veins* carry Blood, yet that they have different Offices, and what is imported into the Heart by the *Veins*, is again exported by the *Arteries* towards the Extremities. For as in this Operation, the Chirurgeon takes particular care to stop the Blood which violently flows from the *Arteries*, either by an *Actual Cautey*, or some *Escarotick Powders*, or else by tying the Vessels; so on the other hand, the *Veins* lie unregarded, having fully experienc'd, upon the like Occasions, that the Blood in them steers a quite contrary Course, and they are only design'd to convey it back to the Heart, after it has answer'd the ends and design of the *Circulation*. This is what perswades me that the Doctor will find it a very hard task to prove what he professes he can do, viz. That as the *Vena Porta* performs the Duty of an *Artery*, so that the other *Veins* in the Body will be found to do the like. If he means that the *Porta*, and other *Veins*, bring Blood from the Heart, this Argument, upon *Amputation*, is an Objection against it; but if his Opinion is, that as the Gaul is separated in the Liver, from the Blood brought into that Part by the *Vena Porta*; that also other Secretions may be made from the *Venal Blood*; then he is desir'd to take notice, That the richer the Blood is, the fitter it is for the *Glands* of the Body to make a separation of several Juices, than when it is become

become depauperated. And the principal reason why the *Venal Blood* is so much poorer than the *Arterial*, is, Because the Blood by being strein'd through the whole Body, has left many nutritious Particles behind it, and has made great expence of Spirits in the various Secretions before it passes into the *Veins*. There may be given a very good Reason, why the Gaul may be separated from the Blood brought into the Liver by the *Vena Porta*, and that in this Case we find an Exception to a General Rule; and till the Doctor can propose a more substantial Reason, that the other *Veins* have their Blood as fit and as proper for the Secretions, I shall keep in the same Mind, that no other Liquor or Juice, in the whole Body, except the Gaul, is separated from any other than the *Arterial Blood*. Why the Gaul alone is made out of the *Venal Blood*, will appear, if we examine the Nature of that Liquor, and its constituent Parts, and the Nature of the Blood brought into the Liver by the *Porta* for the separation of it. And first, The Gaul is observ'd to be inflamable, and that it will burn like Spirit of Wine, as will likewise those Stones that are taken out of the *Vesica Fella*; and by the Chymical Analysis of it, we find its Composition to be chiefly Oil and *Volatile Salt*. If then we can prove that the Blood in the *Porta* has these two ingredients, what should hinder but the Gaul may easily be separated from it? We need then only consider, that the *Spleenick* and *Miseraick Veins*, do unite and carry two different sorts of Blood into the *Porta*; by the first Blood passes immediately from the Spleen, which by its Composition, its *Nerves* and *Arteries*, which terminate into an innumerable quantity of *Vesicles*, and



and the necessity there is that the Blood should in a manner Stagnate in that Part, and for several other Reasons, seems a very proper place wherein the Blood may ferment, become more fine and spirituous, and arrive to a degree of Volatility. The Blood which is brought from the Stomach and Guts by the other Vein, is mix'd with a fat and unctuous substance, continually sent into it from the *Adepose Vessels* of the *Omentum*, as is observable in opening a Frog, and cutting the *Porta*; and at the same time pressing with your Hand the *Omentum*, an Oil may be plainly discern'd to swim upon the Blood which flows from that *Vein*; so that here we have the two principal ingredients that go to the composition of the Gaul, which was what I propos'd to prove, and therefore hope that this digression may be excusable. But to return to the Argument upon *Amputation*, tho' it must be confess'd that the Blood is prevented from passing in its usual Road, yet it does not follow that a stop is put to the *Circulation*, and wholly ceases; for tho' the Trunk of the *Artery* is divided and taken off with the Limb, and the passage of the Blood from the end of that Trunk is obstructed by its growing afterwards into a Ligament, yet we must consider, that from all the larger *Arteries* of the Body do proceed an infinite number of *Ramifications*, through which the *Arterial Blood* is convey'd to the Parts for their nourishment: It is then easie to conceive, how by some of these Branches, which remain entire, and have receiv'd no hurt or prejudice from the Knife, the Blood may pass as usually to the end of the Stump, and afterwards being extravasated into the substance of the flesh, may be return'd by the *Capillary Veins*,  
whose

whose mouths lie open to receive it, and carry it back to the Heart.

In the operation of an *Aneurisme*, it may as well be objected that the *Circulation* is stopp'd; but there is as little reason to suppose such a thing as in an *Amputation*, for tho' in this Case some considerable *Artery* is ty'd by a Ligature, and the Blood cannot pass to the Extremities by it, and no Pulse is felt there, yet in a short time we find that those *Ramifications*, which are every way distributed from the *Artery*, distend themselves to receive a larger proportion of Blood, and to convey it to the extreme Parts, whereby the Pulse returns in less than half an hour, and is felt in the same place as formerly it was. And if we tie the *Jugular Veins* in a Dog, that no Blood can pass, or be return'd by them to the Heart, we shall perceive no alteration, or any ill effect upon the Dog, by the Stagnation of the Blood in the Brain, but by a dissection of him afterwards, we shall find that the Blood continu'd to Circulate, and that the *Capillary Veins* are distended to a great bigness, in proportion to the Blood that should have been return'd by the *Jugulars*. But because that after an *Amputation*, suppose of the Arm, neither the *Capillary Arteries* nor *Veins* seem to be ere the more distended, but the contrary appears by that Part's growing less, and in a manner wasted, the Question may be ask'd, What becomes of that quantity of Blood which was formerly sent for the nourishment of the whole Limb? It may be Answer'd, That since there is not requir'd so much Blood for the nourishment of a part, as was necessary for the whole, the Heart distributes but just what is sufficient for the particular Uses of that Part which



which remains after *Amputation*. So we see Nature takes care not to send any Blood into the *Ductus Communicationis*, when she sees no farther occasion for a passage for it that way, but immediately, when Infants receive the Air into their Lungs by Inspiration, we find that it presently alters its Scituation, by an extraordinary piece of Mechanism, and grows of no use, but is quite clos'd up. It is then no wonder, that the *Veins* and *Arteries*, after an *Amputation*, grow narrower and more contracted, since they do not admit the same quantity of Blood through them, as when they were to supply the whole Member with Blood proper for its nourishment, and return the remainder back again to the Heart. I have now done with their Objections, which appear to have been so very ill grounded, that from them no one can entertain a bad Opinion of the *Circulation*, but be rather inclin'd to think it impossible any thing more material should be alledg'd against it, whatever the *Antic.* boast they can perform to its Prejudice and Disreputation.

What I next propos'd to my self, was to prove that those very Reasons the *Antic.* give for the Spirits being center'd in the *Left Ventricle*, as a Store-House for 'em, did serve rather to confirm us in the Opinion, that nothing but Blood can pass thither, or be afterwards sent into the *Arteries*: And tho' it should be granted, that these Spirits were there Deposited, yet that 'tis impossible to account for those Effects in the Body, which by the *Antic.* are ascrib'd to the Spirits as their Cause, without any other necessity for the Blood, but only as a *Vehi*cle for these Spirits continually moving through it, and agitating its

its Particles. The *Antic.* quote *Harvey, Lower, de Back,* and others, to prove that there are such things as Spirits in the Blood, when at the same time no Person can deny their Existence, but must be very often sensible of their irregular and tumultuous motions, and find great disorders from a deficiency or want of 'em in the Blood. Thus far both sides agree, but still there is a vast difference between those Aereal Spirits which they say come from the Air into us, drawn in by the Heart, and puls'd by the Lungs into the *Left Ventricle*; and those which by the *Circulators* are suppos'd to be immediately generated from the Blood, and as its purer and more subtile Part may still be said to be immediately mix'd and united with it, as Wine and its Spirit make one Body. There is great difference between those Spirits, which according to the *Antic.* proceed from the Chyle as soon as it is receiv'd into the *Right Ventricle*, and are immediately transmitted through holes in the *Septum* into the *Left*; and those, which tho' they are suppos'd to owe their Being to a supply of Chyle as the first and material Cause, yet not before it has been thoroughly chang'd by often and frequent *Circulation*, and first converted into Blood, before it can be proper for the producing of Spirits. I confess that the Question, Whether the Air is admitted into the Blood by Respiration, has been much Controverted by the *Circulators*, and some of 'em are for the Affirmative, and bring Arguments to defend this Opinion: But since the Truth of the *Circulation of the Blood* does not depend much upon either one or the other Hypothesis, or need fear any Sentence of Condemnation tho' the Air be admitted, I shall no otherwise op-



pose that Opinion, than by shewing that the mixture of the Air with the Blood, will not answer all the Intentions and Purposes of the *Antic.* any more than their Method will appear rational, which way they suppose these Spirits can be transmitted into the *Left Ventricle*. And first, as to the passage they assign for the Spirits to pass from the Chyle in the *Right Ventricle* into the *Left*, is by imperceivable holes in the *Septum*; which if they had said they had ever seen 'em, the Discovery would have deserv'd a Consideration, and perhaps it had been necessary to find out a use for 'em, tho' different from what the *Antic.* assign. But not only to confess that these passages are imperceivable, but that they are wide towards the *Right*, and extremely narrow as they enter into the *Left Ventricle*, only proves that they are industrious to lay hold on any shadow that may contribute the least colour to their Hypothesis. If these holes had been sometimes discern'd there, might not they be look'd upon as some defect in Nature, and something very unusual, since the Modern Anatomists have not taken the least notice of 'em? And *Diemerbroek* himself confesses, he never could discern any but what was accidentally made by a Probe, as he was searching too narrowly after 'em. Besides, How can these Spirits be imagin'd to pass from one *Ventricle* to another, when 'tis certain that both contract at the same time? How should the *Right* send these Spirits but when it Contracts? And how should the *Left* receive 'em when it is in the same State of Contraction, as not to admit Spirits, or any thing else; for want of a cavity sufficient to contain 'em? So likewise the *Antic.* affirm, That there is a necessity  
for

for the admittance of the Air into the Blood, for ascending the flame of Life, the creating Spirits, and that the Blood acquires its florid Colour by the mixture of the Air as it passes through the Lungs, yet they give but a lame and unsatisfactory Account how this Air should arrive at the *Left Ventricle*, to be kindled continually into flashes as fast as it is expended upon the Parts, and by Perspiration. Like the *Pythagorean* Philosophers, they place a Fire at the Centre, without giving any reason either for the necessity of its Existence, or which way it should come there. If we should allow that some small quantity might pass into the Blood, and insinuate it self through the tender substance of the Lungs, being first incorporated with the *Mucus* that lines the inward Surface of the *Trachæa*, yet this way will not suffice for that constant supply of Air as should cause those Effects the *Antic.* speak of; and therefore they have recourse to the *Anastomoses* between the *Bronches* and *Pulmonary Artery*, which have hitherto been as imperceivable as the holes in the *Septum*. Besides, had there been so free a communication between the Air and the Blood-Vessels, and if it was true that the heat and motion of the Parts of the Body did depend from the Air, thus transform'd into vital Spirits, might we not reasonable suspect this ill consequence, That the Blood would become too Spirituous; That those Spirits would be so far from cherishing the Body, that they would induce several Diseases; And being sent into the Parts with violence, would sooner invade than nourish 'em? Would easily dislodge many Particles, and wholly disperse 'em? But supposing that the *Venal Artery* was design'd



by Nature for the transmitting Air into the Heart, it seems that the Blood, which the *Antic.* themselves confess to be in it, would greatly hinder the free passage of Air through it, and prevent its coming to the *Left Ventricle*. The same incommodity would arise, as when some part of what we drink goes the wrong way down the *Trachæa*, there is a Convulsive motion always attends, till such time as the humidity is brought up again, or entirely wasted. If the Blood owes the continuance of its burning to the Air, the Question may be ask'd, Why in Fishes, whose Blood, if not actually cold, yet is extremely so to the touch, the Air should produce such a different effect, and instead of spiritualizing and heating the Blood, should rather make it chilly and dull in those Animals, as also in all Amphibious Creatures. As for the difference in the colour of the Blood contain'd in the *Arterial Vein*, and that in the *Venal Artery*, as it passes into the *Left Ventricle*, it being in this of a Scarlet Complexion, and much more florid than in the other, argues only that the Blood receives an alteration in the Lungs, and perhaps too by the Air, but I cannot be perswaded that 'tis occasion'd by its nitrous Quality diffus'd through all the Particles of the Blood, since the Experiment of mixing *Nitre* will be so far from bestowing a redness to the Blood, that it not only presently coagulates it, but turns it extreamly black. Nor will the Doctor's Experiment avail any thing, that the Blood, when let out of a *Vein*, shall be much redder in that Part which is expos'd to the Air; and the bottom, tho' blackish, if it be turn'd upwards, will presently recover its former floridity: and still what part the Air has least influence upon, shall

shall presently change to a dark colour. In answer to this, we must consider that Colours in any Liquors proceed from a particular disposition and situation of the Parts, in respect of one another, and according as the Pores of some Liquors receive more or less of the Rays of the light, and reflect or refract 'em differently; so are their Colour various, and may be alter'd as often as the Parts change their situation. And therefore, tho' we say that this florid colour in the Blood is owing to the Air, yet there is no necessity to suppose that the nitrous Particles in it, or any others whatever, are of that Nature, as by mixing with the Blood, to give it so great an alteration. It may be easily explain'd by the pressure of the Air upon the Superficies of the Blood, which as soon as let out of the Veins becomes broken and dissolv'd, and the *Globali* more and more divided, according to the time it stands, and consequently can easier admit the Rays of Light than reflect 'em back to our Organs, and therefore it inclines to a darkish colour; but the Air pressing upon that Part which is most expos'd to it, unites the Particles of the Blood, brings 'em nearer to one another, and the Pores becoming more contracted, make a greater resistance to the Rays, and reflect 'em with greater facility, till such time as the *Serum* swimming uppermost, shall prevent the efficacy of the pressure of the Air. We shall examine in their order the chief Reasons which induc'd the *Antic.* to give this Priviledge to the *Left Ventricle*, as to be a Repository for the vital aeral Spirits, and we shall find that the great Effects which are ascrib'd to the Spirits, may be far more intelligibly explain'd,



explain'd, according to the Rules of *Circulation*, without any dependance upon 'em.

First they affirm there is a necessity for some place to reserve this fire and flame of Life, and none appears more proper for that purpose than the *Left Ventricle*, it being every way stronger, rougher, and more compact, than the *Right*; insomuch, that according to the Confession of *Harvey*, the Heart seems to have been made for its sake. And the rest of the *Circulators* own the Effect of three Spirits breaking forth into a flash, when they unanimously agree, that the *Arteries* swell only by these Spirits, sent into 'em by the contraction of the Heart.

As to the first part the Argument is very weak and frivolous, since there is no necessity for any Fire or Flash in the Heart; nor indeed is it possible it should subsist in the left Ventricle, where it has been prov'd that both Blood and Humidity abound; for they being quite opposite, and of a contrary Nature, one would infallibly destroy the other. There is certainly a Heat in the Blood, consisting in a Motion of its Parts, and continually maintain'd by the Vital Spirits, which is the subtile and most efficacious Part of the Sanguineous Mass, and by its Presence constitutes the Perfection of the Blood. But why I can't consent to believe that such a Fire as the *Antic.* speak of is contain'd in the *Left Ventricle*, is, Because consequently the Heart would far exceed in Heat all the other Parts of the Body; but the truest Method we have to understand, Whether the Heart be so extremely hot or no, is by placing a Thermometer upon that Part where they say the Fire is kept, and another upon the *Viscera* in the *Abdomen*, where we shall

shall perceive little or no difference in the rising of the Liquors, but they will both remain pretty near in the same degree. That the Walls of the *Left Ventricle* are so thick, and its *Valves* furnish'd and fortify'd with such strong and numerous *Fibres*, it is upon this Account, that they might not only resist the pressure of the Blood against 'em, but chiefly contribute to its expulsion over the whole Body: The force with which the Blood is thrown from the *Left Ventricle* is so far surpassing, and greater in proportion than that of the *Right*, that according to the Computation of *Borelli*, it is 180000 times stronger, and ought to be so, since the Blood is to be expell'd from that *Ventricle* through all the solid and more remote Parts of the Body, and overcome the opposition it must meet with in passing through the infinite turnings and circunvolutions of the smallest *Capillaries*, when the Blood from the *Right* is only to circulate through the soft and yielding Substance of the Lungs. Now the Blood's passing from the Heart into the *Arteries* by jerks, according as the Pulsation is perform'd, and this being the general Opinion of all the *Circulators*, shews plainly that their meaning could never be, that the Vessels swell only by the Spirits in them; for besides, that it would be destructive of the *Circulation*, we continually find 'em to express themselves in quite different terms. *Hinc Clare apparet motum Cordis & Arteriarum esse à Sanguinis impulsu*, says *Harvey*, p. 10. And again, says *Dr. Lower*, *Impulsu Sanguinis Arteriam distendi*. The Spirits may indeed be look'd upon as one Cause of the dilatation of an *Artery*, tho' not the Sole and Principal; but then it must be explain'd



plain'd after a different manner from what the *Antic.* have done, not by the Vital aeral Spirits, but the Animal separated in, and proceeding from the Brain into the *Fibres* of the *Arteries*, whereby they must produce this effect, *viz.* That the sides of the *Arteries* be distended, their ends brought nearer towards their Centre, than when they Contract, and the Spirits spend themselves upon the Parts.

The next Argument the *Antic.* propose, to confirm their Opinion of Spirits being in the *Left Ventricle*, is, From the immediate and sudden Death from a wound receiv'd in that Part.

But in Answer to that it may be said, That it argues not so strongly for the Spirits, as for the Bloods being there; all wounds that penetrate into either *Ventricle* are always Mortal, but if those which besal the *Left* are attended with a more sudden Fate, is it more reasonable to think that the passing away of the Spirits through the wound, and the Parts being depriv'd of 'em, was the chief occasion; or ought it rather to be imputed to the loss of the Vital Blood, which is the Support of Life to the whole Body, and from which Spirits are separated in the Brain for the sense and motion of its Parts? The Blood which should have been sent into the *Aorta*, and part convey'd to the Brain, finds now a freer and more open passage by the wound, and is all discharg'd into the Cavity of the Breast; whereupon the Animal Spirits being no longer separated in the Brain, and cannot be convey'd by the Nerves to the several Parts, Respiration stops in an instant, and all the Senses and Faculties of the Body, depending upon the Animal Spirits, immediately cease. I foresee this Reason will  
appear

appear to the *Antic.* very unsatisfactory, till they are Convinc'd of the Existence of Animal Spirits, which can't be better done than by Answering some of their chief Objections against 'em, and against an Opinion agreed on by all Hands, That Sense and Motion depend entirely upon the Influence of the Animal Spirits.

Their first Objection is grounded upon the Trial of cutting a Heart into several pieces, and its moving a considerable while afterwards, which it could not perform, if that Motion and Contraction was from the Animal Spirits.

To this it may be Answer'd, Tho' it may be true that not only the Heart, when taken out of the Body, but other Parts of some Animals, tho' divided into never so minute pieces, do continue a Motion, and the Heart Pulses as formerly, tho' it can have no communication with the Brain; yet this does not destroy the Notion of Animal Spirits, or prove, that because in these Instances no Spirits can pass from the Brain into the Heart, therefore its Pulsation is owing to the Vital aerial Spirits lurking in the Pores, and endeavouring to pass through its Substance. *Harvey* ascribes the Cause of this *Phænomenon* to another Principle, *Quod cor quorundam animalium etiam si in frustra dissectueris, pulsum faciat & palpitet, hoc forte proprium vivacioribus quorum Radicale humidum glutinosum magis, aut pingue & lentum est, & non ita facile dissolubile.* Thus much farther may be said, That tho' the *Nerves* and *Fibres* of the Heart are very much divided, and there is no communication from the Head to that Part, yet there are at least some Portion of Nerves remaining, and those full of Ner-



vous Juice, or Animal Spirits, which by reason of the Porousness of the Nerves, may be suppos'd to distil leisurely and *guttatim* into the *Fibres*, which causing a fermentation and dispoision in the Muscles of the Heart, excite a Motion and a Pulsation, which will continue till such time as the Animal Spirits are quite exhausted, and spent upon the Part. Nor can we well dispute of the Existence of these Spirits, or Nervous Juice, since we see, when a Nerve is any way hurt, or but prick'd, that it is with some difficulty to stop its continual weeping out from the wound.

The next thing the *Antic* object against the Animal Spirits, is, That they observe the Heart to move before the Brain is capable of elaborating Animal Spirits; or before the Blood, which is the Matter from whence they must be generated, does exist in the Body. Besides, that the Motion of the Heart is much encreas'd from Wine, or any other Spirituous Liqueur, which cannot proceed from Animal Spirits, since they were never suppos'd to be in them.

In Answer to this it may be said, That if it be true what the Modern Anatomists agree in, that the Parts of an *Embryo*, from the first Conception, are all entire and perfect, and that their increase and augmentation is only from an accession of new Particles, according to their several dimensions; there is no reason to imagine why the Brain is incapable to separate Animal Spirits, and send a sufficient quantity of them, as is requir'd, for the Motion and Contraction of the Heart. And tho' at first it must be granted, that the Vessels of an *Embryo* have only a substance

substance in them of the consistence of Jelly, yet it must be confess'd, that fluidity, and some other qualifications, are only wanting to make it perfect Blood; for at the same time as the *Punctum Saliens*, or *Leaping Bubble* appears, which is the Heart of the Animal, at the same time the first rudiments of Blood may be easily discern'd. We may conceive how those tender and delicate *Stamina* of the *Embrio* may at first be commodiously supply'd with Animal Spirits, for their enlivening and motion, if we consider that the Seed of the Male contains a great quantity of 'em, which passing by the *Umbilical Vessel* into the *Vena Cava* of the *Embrio*, and other Parts, puts the Jelly it meets with in its passage into motion; and at last, being convey'd by several small rivulets from the Trunk of the great *Artery* to the Brain, causes it to separate Animal Spirits from the Jelly, now become fluid and fit for that purpose, which are immediately sent to the Heart, and other Parts, for their Motion. But because a previous Contraction of the Heart seems necessary to force these Spirits to the Brain, it may be said that all Parts, which before lay close and flat, being now something dilated and more open, they may by their great volatility easily disperse themselves, or at least give the Heart a sort of Puffation and Vibration, as is requisite for their passage through it. *Quia animalium sperma & spiritus prolificus palpitando exit velut quoddam animal, ut Notavit Aristoteles.* As to the latter part of their Objection, since it is manifest that the Spirits of the Wine are no other than Natural Spirits, and but Vital in the Heart, they can be no otherwise Instrumental in the Motion of the

N 2

Heart,



Heart; than by agitating the Particles of the Blood, whereby it runs faster, and in a larger quantity, to the Heart and the Brain; and consequently the Animal Spirits are more plentifully separated, and sent in a greater proportion to the Parts: Besides, that Spiritous Liquors may raise the Pulse, and encrease the motion of the Heart, before their admission into the Blood, by irritation upon the Nerves of the Stomach, and perhaps sometimes after the same manner, as the very sight of some Medicines have been observ'd by *Galen* to have the same effect upon some Persons, and their Pulse have been as much alter'd as if they had been taken inwardly.

There only remain two Arguments to be consider'd, whereby the *Antic.* endeavour to support their Cause against the *Circulation of the Blood*, and the Notion of *Animal Spirits*: The first is taken from the hard labour of the Heart and Lungs after some violent Exercise, which they say could only happen from a great loss of the Vital aereal Spirits transfusing too copiously through the Pores, and is farther prov'd from the Sweat appearing in form of bubbles upon the surface of the Skin. The second is from a false Opinion, That Inflammations in any Part proceed only from the Spirits gathering there in too great abundance, and can in no wise be imputed to the Blood, since its colour, as for Example, in the back of the Hand, appears bluish, and nothing near so florid as Inflammations generally are.

'Tis true, that after Running, or any other hard Exercise, we observe these effects they speak of, but still we may find other Causes than from the loss of the Vital Spirits. At that time the whole Body being  
violently

violently mov'd, the Muscles do compress the Blood Vessels, and drive the Blood rapidly to and fro, putting it into great Commotion; which continuing to move vigorously, as it draws near the Heart, is gather'd in too great a quantity in the *Right Ventricle*, whereby it becomes almost choak'd. So that the Lungs labouring, and meeting with some difficulty in forcing the Blood along, it is inflam'd in the Heart, rarify'd and loosen'd in its Constitution, and exhales a great quantity of Sulphur, which carrying with it the Serous Particles of the Blood cause Sweat. The Doctor can never account by his Hypothesis for the difficulty of Breathing, and other Symptoms, after hard Labour; weakness and weariness of the Limbs, which always accompany it, are from a loss of Spirits, not Vital but Animal, when they happen to be wasted by being sent into the Muscles; and so great supply as is necessary can't be on a sudden Regenerated. Now since it admits of a dispute, at least, Whether there are any such Vital Spirits as the *Antic.* imagine, or that they are distinct, and can act separately from the Blood, we shall see with how little reason they ascribe several Effects to them, and an Inflammation among the rest; which may be easily explain'd from a too copious Collection of Crass and Viscid Humours, and Obstructions arising from thence, which if they continue for any time, then by the jostling together of many and various Particles, Salt ones with Sulphureous, Acid with Alcaleous, an Inflammation presently ensues. How should a redness in any Part, or an Inflammation, continue for so considerable a time as is generally observ'd, if it was caus'd by these Spirits, which according to the *Antic.* Confession,



fession are of so Volatile a nature, that as soon as they are sent from the *Left Ventricle* to all the Parts, and by their cherishing heat warm'd and enliven'd 'em, do immediately transpire and evaporate through the Pores of the Skin? How happens it that in several Species of Inflammations, as an *Angina*, or *Erysipelas*, Spirituous Remedies prove often successful and effectual towards their Cure, when in the first Case too great Coolers, which by their Nature should diminish the Spirits, make the Distemper much worse, and often produce strange Effects, as Fluxes of Blood from the Nose, and other ill Accidents. That Phlebotomy is necessary in Inflammations, is it because the Spirits are thereby lessen'd, or rather that some part of the Mass of Blood being drawn out of the Body, the motion is swifter, and the Heart throws the remainder with greater rapidity, whereby the congeal'd Humours stagnating in any Part are more liable to be unfix'd and shaken, and the *Circulation* made free: Besides that the Veins being empty'd, the Blood and Humours, which before were the occasion of the Inflammation, are now call'd from the Part, and attracted, or what other Name you please to call it, in order to fill up the vacancies in other Vessels, that have at least a less share of Blood in them; so that those which before were too much distended, do now easily recover their former spring and force. *Idcirco Venæsectionem præscribimus ut meatus aperiamus, peccantem materiam minuamus, & transpirationem liberam reddamus*, says *Fab. Hildanus*. But because they Object, that a redness and heat so intense as in an Inflammation, can proceed but from the Spirits only, the Question may very well be

be ask'd, Whether they did ever see 'em, or can tell what colour the Spirits are of? Whether they are so fiery in themselves, or at least more florid than the Arterial Blood? The only Observation they have made of the colour of the Blood, is from its appearance upon the back of the Hand, which being no part of the Arterial Blood, but only what is return'd by the Veins, broken and dissolv'd, its Particles soft and flexible, it is the best Reason can be given for its bluish Cast.

## F I N I S.

## E R R A T A.

**P**Age 18. line 4. for *flood* read *florid*. p. 21. l. 2. f. *desueret* r. *deficeret*.  
 p. 24. l. 14. f. *bigness* r. *thickness*. p. 33. l. 23. f. *Limphaticks* r. *Limphatick*.  
 p. 40. l. 11. f. *distinctione* r. *distentione*. p. 43. l. 27. dele again.  
 p. 54. l. 8. f. *Heart* r. *Breast*. p. 64. l. 28. f. *Vein* r. *Wen*. p. 70. l. 2. f. *renew'd* r. *return'd*.  
 l. 7. f. *Pore Bellows* r. *pair of Bellows*. p. 82. l. 10. dele 'em. p. 80. *Riolanus* §iv. r. §iv.



MVSEVM  
BRITAN  
NICVM